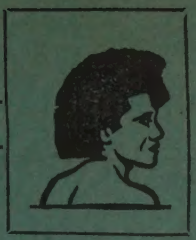
VOL. 31 1961



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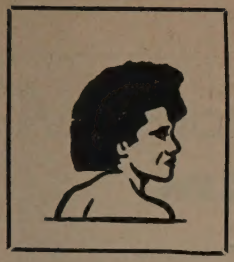

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ISSUED BY THE DEPARTMENT OF AGRICULTURE, FIJI

EDITORIAL . . .

An apology for the delay in producing this number of the Agricultural Journal is due to its subscribers. It is only too apparent, however, that to produce four numbers of the journal per year together with an assortment of farmers' bulletins and leaflets is a formidable task indeed and one that demands a great deal of time of the limited staff of the Department. However, every endeavour will be made to produce one journal at least per year which, it is hoped will be somewhat larger than in the past. The annual subscription, which has not changed for many years, will continue to remain the same.

The attention of readers is particularly drawn to Mr. Yelf's article entitled " A Valuable Contribution to the Poultry Industry of Fiji ". In it, he describes the development of a project to supply quality day-old chicks to both small and large farmers which was built up by the Department at Koronivia Research Station. This proved a popular service and in 1960 *some* 19,500 *chicks were sold. It is gratifying to record, however, that this service is now being successfully provided by a reliable and enterprising commercial undertaking and the Department, having pioneered the work in the first place, can now conclude this work in the knowledge that the public can obtain their cross-bred chicks from a local supplier. The Department will, however, still maintain pure-bred flocks and sell pure-bred chicks.*

AGRONOMY . . .

WEED CONTROL IN DRILLED RICE

BY P. L. RHODES

Weeds are a limiting factor in dryland rice production in Fiji. It has been shown that good drilled crops can be grown without the need for flooding if adequate weed control can be achieved.

When machine drilling of rice was being pioneered at the Principal Agricultural Station at Koronivia, a row spacing of fourteen inches was used and weed control was achieved by hand weeding; this proved heavy on labour and was a limiting factor to the practical extension of this method which has many other advantages.

THE TRIALS—FIRST SERIES

In order to provide a practical solution to the weeding problem a number of trials was laid down at Koronivia from 1957 onwards. These approached the problem from two angles namely, cultivation by horse or tractor and chemical control by weedicides. In the cultivation trials success depended on wide row spacings, whereas optimum results would be expected from weedicides with narrow row spacings. The trials at Koronivia covered all these aspects.

A comparison was first made between three differing methods of weed control—spraying with a weedicide, hand hoeing and horse hoeing. Each treatment was carried out under what was considered the optimum spacing for that treatment.

A close row spacing of six inches was used for the weedicide treatment. This consisted of 1·4 lb. of acid equivalent of 2, 4-D Alkinoamine salt, applied six to eight weeks after drilling. The object of the close spacing was to encourage the rice to smother the grass weeds not controlled by the weedicide.

The hand weeded plots were sown with twelve-inch rows which approximated to the previous standard fourteen inch rows.

Finally, the horse cultivated plots were sown with eighteen-inch rows, this being considered the minimum possible spacing for this method. A seed rate of 80 lb. per acre was used for each treatment.

The trials were carried out over three years' cropping. In the first two years the variety Serendah kuning was grown; very poor yields were obtained in the second year of the trial owing to severe leaf yellows damage. B.G. 75 (B.G. 79 to overseas readers) was used for the third year of the trials.

The results are set out in table I.

TABLE I

YIELD OF CLEAN, DRY PADI—LB. PER ACRE

	1957–58	1958–59	1959–60	
Variety	Serendah Kuning		B.G. 75	Average Yield
6 inch rows, sprayed with weedicide ..	1,055	362	1,265	894
12 inch rows, hand weeded	1,902	549	2,439	1,630
18 inch rows, horse cultivated	1,606	799	2,058	1,488
M.S.D. 5 per cent ..	156	420	455	....

The hand weeded plots gave the best yield, followed closely by the horse cultivated plots; both yielded nearly twice as much as the sprayed plots.

On the basis of yield, therefore, it is evident that the eighteen inch spacing with horse cultivation is likely to be the most effective and economical method of weed control for anything but the smallest areas.

THE SECOND SERIES

In some seasons in the wet areas of Fiji it was thought that it might not always be possible to get on to the land to carry out cultivation work on account of prolonged wet weather. A second series of trials was therefore laid down to determine whether or not chemical weed control would be justified as an adjunct to cultivation, using an eighteen inch row spacing. The trials extended over two years and the treatments were as follows:—

1. Control—no weeding
2. Cultivation only
3. Spraying followed by a later cultivation.
4. Spraying only.

In the first year one cultivation was necessary in treatment 2 but in the second year two cultivations were required. In the spraying plus cultivation treatment—treatment 3—only one cultivation was given.

Spraying was carried out about six weeks after drilling. In the first year the sodium salt of M.C.P.A. was used at a rate of 1 lb. of acid equivalent per acre; in the second year the Alkinoamine salt of 2, 4-D was used at a rate of 1·3 lb. of acid equivalent per acre.

The results of this trial are shown in Table 2.

TABLE 2

YIELD OF CLEAN, DRY PADI—LB. PER ACRE

Variety	1958–59	1959–60	Average Yield
	B.G. 75	Patarka	
Control	2,500	1,962	2,231
Cultivation only	2,750	2,640	2,695
Spraying plus cultivation	2,692	2,301	2,496
Spraying only	2,395	2,086	2,240
M.S.D. 5 per cent ..	314	157	....

It will be seen, from the results in Table 2, that spraying would not have been worthwhile in these trials if cultivation had not been possible. Yields were high, even in the control plots, due mainly to good preparation of the land prior to drilling and to the use of rotations. While both fields had a representative selection of broadleaved and grass weeds, the latter, as is common in nearly all drilled rice land, were sufficiently numerous to cause serious competition in the sprayed treatment plots, the yields which averaged only slightly better than those of the control plots.

DISCUSSION

As a result of these trials, the recommended spacing for drilled rice has been altered from fourteen inches to either eighteen or twenty inches. Some 500 acres were drilled by tractor and weeded by horse-drawn cultivators with most satisfactory results in the 1959–60 season and in the 1960–61 season this was increased to 1,000 acres. In 1961–62 continuous wet weather caused the acreage to drop to 700, but the wet conditions enabled those who were unable to drill to transplant instead.

From experience gained during the conduct of these trials and subsequently it has been found that good control of weeds can be obtained by inter-row cultivating even in wet seasons such as was experienced in 1961–62.

As was mentioned above the yields of the control plots shown in table II were good due to good preparation and to the use of rotations. These two factors are extremely important especially in wet seasons and without them control by inter-row cultivation can be well nigh impossible. Where tractors are used, ploughing shortly before drilling should be avoided as this brings a fresh crop of weed seeds to the surface, instead weed growth should be controlled by discing. Where animal power is used discing is not possible and since harrowing with spike tooth harrows will only control small weeds, ploughing is usually necessary shortly before drilling. This final ploughing should be as shallow as possible.

The objects of the preliminary cultivations are to germinate and then to destroy weeds. Care should therefore be taken not to allow these weeds to seed between cultivations.

Three types of cultivating equipment have been tried, a horse-drawn cultivator, a mechanical rotary hoe, and a tractor-drawn steerage hoe. The horse-drawn cultivator has proved the most satisfactory; it can be used irrespective of the weather and it also tends to earth up the rows, not only smothering the weeds but also giving the rice plants additional support, thus making them more resistent to lodging; it was also quicker than the rotary hoe used, one man being able to cover an acre in an eight-hour working day, whereas it was only possible to cultivate half to three quarters of an acre in a day with the rotary hoe. The eighteen-inch rows were found to be too close for the steerage hoe to operate satisfactorally; it has however been tried in twenty-four inch rows with most satisfactory results, the disc coulters being reversed to give a degree of earthing up of the plants. The rate of work, using a five-row steerage hoe, was more than an acre an hour; conditions, however have to be dry. Further experimentation is being carried out with twenty-four inch rows.

The lighter the horse drawn cultivator the better as less damage will be done to young rice. Heavy cultivators tend to move too much soil which can easily bury the small rice plants causing an uneven stand. If the weather is not entirely satisfactory it is still necessary to cultivate to check the growth of the weeds, even if it is not possible to kill them. If the first cultivation is left too late weed control becomes more difficult, as apart from the weeds being larger, the taller rice shades the ground preventing it drying out quickly This of course is additionally important in a wet season. If the weeds cannot be entirely controlled good results can still be obtained by keeping them in check and allowing the rice to get ahead. Under such circumstances one hand weeding after the rice has almost made a complete canopy will usually be worthwhile. If the crop is growing badly due to poor preparation, or exhausted soil, fertilizers applied after a weeding will enable the rice to grow away. Urea at 1 cwt. or Sulphate of Ammonia at 2 cwt. per acre is all that is necessary on most soils. Well grown rice will supress new weed growth once it is large enough to form a good canopy. Poorly growing rice will never get away from the weeds and constant weeding will be necessary to obtain even a mediocre crop.

RECOMMENDATIONS

It is most important to grow drilled rice in a rotation preferably with a pulse crop such as mung or urd, it may also be necessary to rest the land occasionally for an entire wet season when a longer term green manure crop e.g. giant cowpea, can be grown. In a system of mixed farming the ideal is to establish a short term grazing rotation. Where rotations are not practised the rice crops will become progressively poorer and weed infestation will increase.

Where the land is too poorly drained to grow a satisfactory pulse crop, and where the farm is too small to carry a mixed farming system, fertilizers will have to be used, and if the weed problem becomes out of hand it may be necessary to puddle and transplant to control weeds. This has the disadvantage of a higher labour require-

ment and the risk of dry weather causing delayed planting and low yields. However, yields are not likely to be as low as from a very poor drilled crop.

Good land preparation before planting will greatly assist with the control of weeds. This is a matter for experience and the methods used will depend on the equipment available. The seed should be drilled as soon after the last cultivation as possible so as to enable the rice to get a good start over the weeds.

If the crop is drilled into a clean field which is fairly fertile only two inter-row cultivations may be necessary. Poor, worn-out land, especially where drilled rice has been grown for a number of years without any rotation will require more cultivations and at least one hand weeding.

The secret of good weed control is to tackle the weeds early and prevent them from getting out of hand; once the weeds, especially grass weeds, have reached any considerable size they are almost impossible to control economically. The first cultivation will probably be necessary not more than five weeks after drilling. Para grass *Brachiaria mutica* must be controlled by preliminary cultivation; if it appears in the growing rice, it must be pulled by hand in the early stages as it cannot be controlled by inter-row cultivation.

In cases where there is a heavy population of broad leaved weeds and few grasses chemical weed control should prove effective. If the rice is growing well one spraying will be sufficient for good control. If however, the rice is not growing so well and there is sufficient light reaching the soil a second crop of weeds may emerge or the few grasses present will flourish and further weeding may be necessary. Chemical weedicides are also indicated for use in transplanted rice, especially where good water control is practised. The field shown in plate 3 contained transplanted rice heavily infested with Pickerel weed, *Monochoris hastata* together with a large population of various sedges including *Eimbristylis littoralis* Gound. *Rhynchospora corymbosa* (Linn). Britton and *Cyperus pilosus* Vahl. which cannot be seen in the photograph; spraying with weedicides gave good control of these weeds. A detailed account of the chemical control of weeds in rice fields has already been published (May 1960).

SUMMARY

1. Trials carried out at Koronivia since 1957 have included hand hoeing, horse cultivation and chemical methods of weed control at different row spacings.
2. The results have indicated that horse hoeing with a row spacing of eighteen inches is the most practical method of weed control for drilled rice.
3. The use of rotations and adequate land preparation are advised to facilitate weed control.
4. Drilling should be carried out as soon as possible after the final preparation to give the rice a good start over the weeds.
5. The first cultivation should be done early before the weeds have grown too large; this will normally be about five weeks after drilling. Even if the weather is wet horse cultivation is still possible.
6. Further cultivations should be carried out as necessary, and if the weeds are bad in the row, hand weeding will be necessary.

ACKNOWLEDGEMENTS

Advice and help have been freely given by the Officer in Charge of Stations Mr. J. D. Yelf. It is also desired to acknowledge the work of Field Assistant Sheik Ali who was responsible for carrying out the field work.

REFERENCE

Mune T. L. (1960)—Agric. J. Fiji 30 (1), 33.

Drilling rice at an eighteen inch spacing Photo—P.R.O.

Cultivating rice drilled at an eighteen inch spacing Photo—P.R.O.

Spraying a severe infestation of Pickerel weed with 2, 4-D in Transplanted rice

Photo—P.R.O.

TURKISH TOBACCO AS A POSSIBLE CROP FOR POOR HILL SOILS

BY J. D. YELF

Various types of tobacco have been tried in Fiji on many occasions and a small industry in cigar type leaf was operating in the Sigatoka Valley before the War.

To-day there are two Tobacco Companies producing Virginia type flue cured tobacco for the local cigarette trade, and the old Fiji twist made from air cured tobacco still thrives.

The competition on world markets for Virginia tobacco is very keen and the chance of Fiji cutting into such markets is not very likely but there is a world shortage of Turkish Tobacco and the climate of the Western side of Viti Levu would seem suitable for the production of Turkish Tobacco during the dry season. Until 1958 Turkish Tobacco had not been grown here and when it was introduced from S. Rhodesia the small size of the leaf was considered very strange.

The variety Soluk was tried on the sandy soils near the sand dunes at Sigatoka, on the marginal cane land near Nadi and in the hills where cane cannot be grown. The yield of cured leaf varied between 400 lb. and 800 lb. per acre. The poor hill soils which have not been eroded are suitable for this crop and during 1961 the leaf grown on the hills behind Nadi was considered promising by a Turkish Tobacco leaf expert. The land on which this leaf can be grown has to support farmers, who, at present, have no economic crop. Often they have large families and this can be an asset in helping with the curing of the crop as all leaves have to be threaded on to strings, also planting the crop takes a lot of concentrated effort as the plant is spaced at 6 inches along rows 18 inches apart.

Turkish Tobacco is needed by the American tobacco blenders to make the type of cigarette which is popular in U.S.A. At present the main source of supply is in the Middle East. Rhodesia is also trying to establish the industry. If a suitable firm were willing to promote the crop in Fiji, it would be ideal for peasant farmers as no capital is required to cure the leaf. It is threaded on to strings 9 feet long and tied on racks in the sun to cure. If the weather is showery it has to be covered with plastic sheeting or carried indoors.

Thus although Turkish Tobacco seems a good crop for the drier side of Fiji, until a Company becomes interested in the crop, it will have to wait for there are no local auction floors on which it can be sold.

CAN FLOTATION OF COCONUTS BE USED TO INDICATE QUICK GERMINATION?

BY N. G. CASSIDY

The manner in which an unhusked coconut floats in water cannot be used to indicate whether the nut will germinate quickly or not. In fact, it merely indicates whether the husk has developed symmetrically or unsymmetrically about the nut.

Claims have been made from time to time, mainly in the Indian literature, that a coconut which floats vertically when placed in water will germinate more quickly than one which does not float vertically.

If such a test could be applied it would provide a rapid way of determining a matter of great importance to the coconut industry in Fiji, where most of the plantations consist of palms which have already passed their maximum productive capacity.

The importance of such a test arises from the close connection which has been shown to exist between quick germination and the subsequent behaviour of the seedling. Liyanage and Abeywardena (1957) found a good correlation between quick germination and early bearing; they also found that early bearers retained their fecundity, and produced good crops of nuts, at least up to the end of the 17-year period of the experiments; and there would not seem to be any likelihood that such fruitfulness would not continue.

The importance which therefore attaches to the replanting of plantations with quick germinating nuts led to a careful examination of the flotation theory.

EXPERIMENTAL

A random group of nuts from a wide selection of tree types on the Sigatoka Agricultural Station was subjected to flotation. The nuts were floated singly in a 44 gallon drum of water. Those which floated vertically were set on one side and those which floated horizontally on the other; the rest were rejected.

The vertical floaters were placed on their sides in sandy soil in one seed-bed, and the horizontal floaters were set out alongside in a similar seed-bed. The beds were provided with overhead shade from a frame covered with coconut fronds. Five such series were set out, at weekly intervals, with ten nuts in each series—five vertical and five horizontal floaters. Germination was defined as the appearance of three inches of plumule beyond the surface of the husk. The date of each germination was noted and the results were examined after each series had run for 140 days.

RESULTS

There was no appreciable difference in the total germination for the two groups: in each case it was 80 per cent. The mean germination period was 113 days for the vertical floaters and 107 days for the horizontal floaters. The difference between these two was not significant.

The results have disproved the theory that vertical floaters are the quickest germinators. At the same time it was considered worthwhile to split open two similar groups of nuts which had been segregated by the floating test as either vertical or horizontal floaters. When the split nuts were examined it at once became evident that the nuts which floated horizontally were symmetical in form whilst the others were not. The figures show that in one case there is the same thickness of fibre on either side of the nut, whilst in the other case this is not so. Since the fibre has a lower density than the nut itself, the thickness of the fibre covering determines which way the nut will float. This is borne out by the fact that all the nuts had their greatest thickness of fibre at the stem-end of the fruit and consequently all floated with the stem end upwards i.e. none of the nuts floated " upside down ".

CONCLUSION

The manner in which a coconut floats in water is determined by the distribution of the fibre about the nut proper and it cannot be used to predict time of germination.

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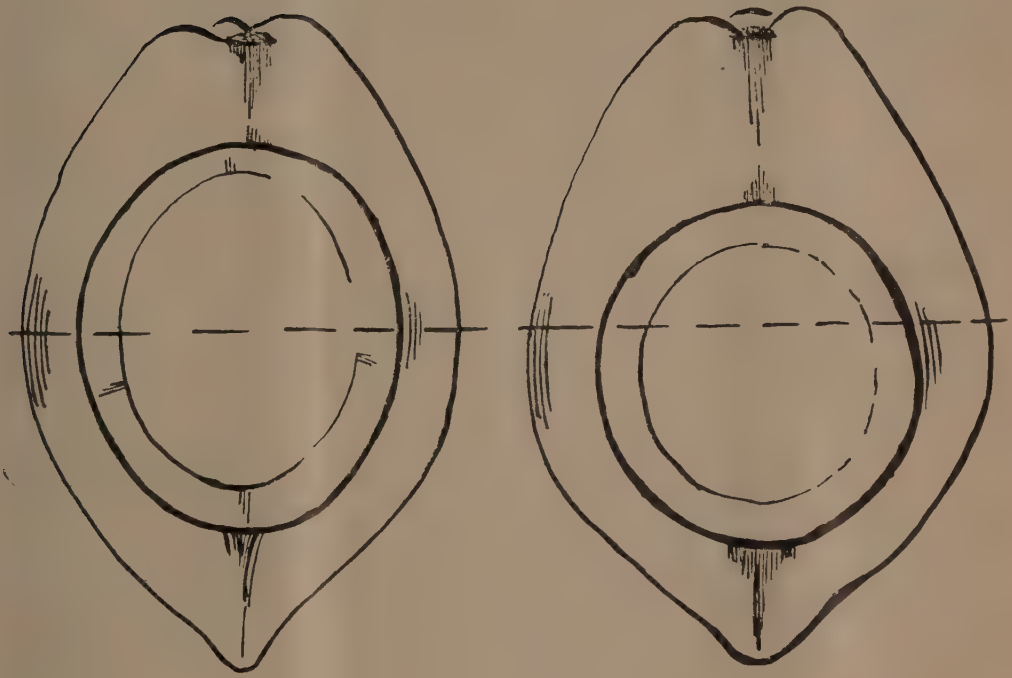


Illustrating symmetrical and assymmetrical Coconuts

The horizontal lines draw attention to the thickness of the fibre on either side of the pericarp. It will be seen that the coconut on the left-hand side has symmetry : the one on the right-hand side has not. The one on the right is a vertical floater.

FORESTRY . . .

THE INDIGENOUS TREES OF FIJI

BY G. WATKINS*

The first of a series of illustrated notes on the trees which are to be found growing in the forests of Fiji. It is hoped that by publishing similar notes on three species or so with each issue of this Journal, most of the trees will be covered in this way.

The first series deals with three timber trees, viz., Kauvula, Dakua and Damanu.

DAKUA

Family: PINACEAE

1. *Botanical Name—Agathis vitiensis* Seem.

Agathis—Greek word for a ball of thread, possibly alluding to resemblance of cone to a ball of thread or twine.

vitiensis—from the Fiji Islands.

2. *Local Names*—Dakua makandre; Dakua; Fiji Kauri.

3. *Distribution*—It is believed that Dakua was much more widely distributed and abundant in the Colony than is the case today. Previous exploitation has reduced the number of larger trees present in the accessible forests, whilst many trees have been destroyed by fire, especially in the drier districts on the western side of Viti Levu. These losses by firing must undoubtedly have been aggravated by the crude methods employed in tapping the tree for resin. A rectangular piece of bark, some 1–2 sq. ft. in area, was removed near the base of the trunk, and, to hasten the flow of the resin, a fire was lit just below the wound.

Dakua is still to be found growing, however, in many forest areas throughout Fiji, but it is probably more abundant in the drier and transitional montane zones than in the wet tropical lowland forest areas. The tree is seldom found as scattered single specimens as it normally grows in small stands in which it is the dominant species. In the drier zones these stands are generally in the valleys but, in the wetter forests, they seem to prefer hill slopes and ridge tops.

4. *Tree Description*—A medium to large sized tree which varies in height from 50 ft. to 100 ft., with lengths of clear bole of 60 ft. being recorded from time to time. Girths of 15 ft. to 20 ft. are not uncommon, although the average girth is usually between 8 ft. and 9 ft. Stems are almost cylindrical and have no large buttresses.

Bark is light brown in colour with a silvery sheen. The outer bark flakes off profusely so that the trunk of the tree presents a dented appearance, which, when viewed in direct sunlight, assumes a distinctive orange-brown hue. Bark slash reveals a rich brown underbark, $\frac{1}{2}$ in. thick, which exudes a copious sticky resin. As the species was tapped for resin in the past, many trees can be found with large swellings near the butt region as evidence of this previous practice.

Leaves are elliptic, $2\frac{1}{2}$ in. x $\frac{3}{4}$ in., borne on short petioles $\frac{1}{4}$ in. long. When young, they are dark green in colour, but older leaves are light green with a greyish tinge. Veins are not clearly marked.

The leaves are arranged in opposite pairs, although frequently the leaves are not exactly opposite to one another. Arrangements along the twigs is decussate, with each pair set at right angles to that of the pair next above or below.

Dark brown galls, speckled white, and up to half an inch in length and width, are frequently found on the foliage.

Flowers—There are separate male and female flowers which occur on the same tree. Male flowers are in cylindrical catkins, up to 2 in. long, and are located in the leaf axils.

*Assistant Conservator of Forests

After shedding their pollen, the flowers fall off leaving a central brown stalk, 1 in. long.

Female flowers are usually at the ends of branchlets. They develop into round cones, up to 3½ in. across. The cone scales are fan shaped, 1 in. broad; they carry one winged seed per scale.

5. *Description of Timber*—Pale yellowish-brown sapwood and a slightly darker heartwood which occasionally has a distinct reddish tinge. The wood is of regular grain with a fine uniform texture. Growth rings are not clearly defined. It is not a heavy timber, 32 lb. per cubic foot when dry, but it is, nevertheless, a fairly strong timber with reasonably good bending qualities under steam. As the surface is not particularly hard, it is easily marked by scratches and indentations.

Sawing in the log presents no difficulty and the timber works very easily with hand-tools; machining properties are also good. It takes nails easily without splitting, holding them fairly well. Air seasoning is rapid with little degrade if properly stacked.

Logs left lying in the forest are liable to attack from pin-hole (*Ambrosia*) beetle, but this is not serious in normal logging operations. Unfortunately, fully seasoned Dakua is one of the most susceptible of the Fijian timbers to attack from dry-wood termites.

The heartwood is fairly resistant to weathering and to decay except under the most unfavourable conditions, such as when in contact with the soil. Preliminary trials have indicated that the heartwood is not amenable to preservative treatment by normal pressure impregnation methods.

6. *Uses*—Because of its special qualities, Dakua is a popular timber which is in great demand for a wide range of uses. It is sold by some sawmillers and traders in two grades, viz., Clear Heart, consisting of the clean and darker heartwood, and Ordinary Building (O.B.), which is of a lighter colour, and also includes sapwood. Both grades have been employed extensively in constructional work, e.g., beams, rafters and top plates etc., but their present high costs and the availability of cheaper substitute timbers is resulting in a reduction of their use for these purposes. O.B. grade now finds its use chiefly as an interior finishing timber, furniture and cabinet making, internal doors and frames. In addition to these same uses, Clear Heart is preferred for such items as external sheathing (weather-boarding), barge and fascia boards, external doors and frames, whilst a specialised use is for kitchen sink draining boards.

Kauri gum, for which the tree used to be tapped, is inflammable and was used by the Fijians as lamps or torches. It was also used in glazing their pottery, but most tapping for all commercial purposes has been prohibited by law, so the practice has now more or less ceased completely throughout the Islands.

DAKUA MAKADRE—*Agathis vitiensis* Seem. (a) Leafy shoot ; (b) Male cones ; (c) Female cone

DAMANU

Family: GUTTIFERAE

1. *Botanical Name : Calophyllum vitiense* Turrill.

Calophyllum—from *calo* (beautiful) and *phyllum leaf)*

vitiense—from Fiji (Viti)

2. *Local Name :* Damanu; Large leaf Damanu (to distinguish it from the smaller leaved Damanu, *C. leucocarpum* A.C. Smith).

3. *Distribution :* Widely distributed in most forest types throughout the main islands and in Kadavu. It is to be found from sea level to the higher mountain ridges over 3,000 ft., although it is most common between 500 ft. and 2,500 ft. above sea level.

4. *Tree Description*—A large tree, 70 ft. high and 6–8 ft. in girth. Bole is clean with little taper and no buttresses, but those of the larger trees are invariably unsound or hollow.

Bark is brown, slightly fissured and flaking off to expose greenish-yellow patches. Slash exudes a sticky brownish sap, smelling strongly of green ginger.

Crown is rounded. Adult leaves are up to 6 in. long and 2 in. wide and are borne on a petiole approx. 1 in. long. They are leathery, glabrous and dark green when mature, but reddish when young. Venation consists of closely parallel veins set at nearly right angles to the mid-rib. Leaves are opposite but arranged decussately on the twigs, with the latter being square in cross section when young.

Flowers are in sweet-smelling clusters of up to a dozen per cluster. A flower consists of four sepals and petals borne on a 1 in. stalk, which is also white in colour, although the centre of the flower itself contains a mass of bright yellow stamens.

Fruits are succulent, non-edible drupes, purple when ripe, ¾ in. long, being nearly round in shape. They contain a single large stony seed.

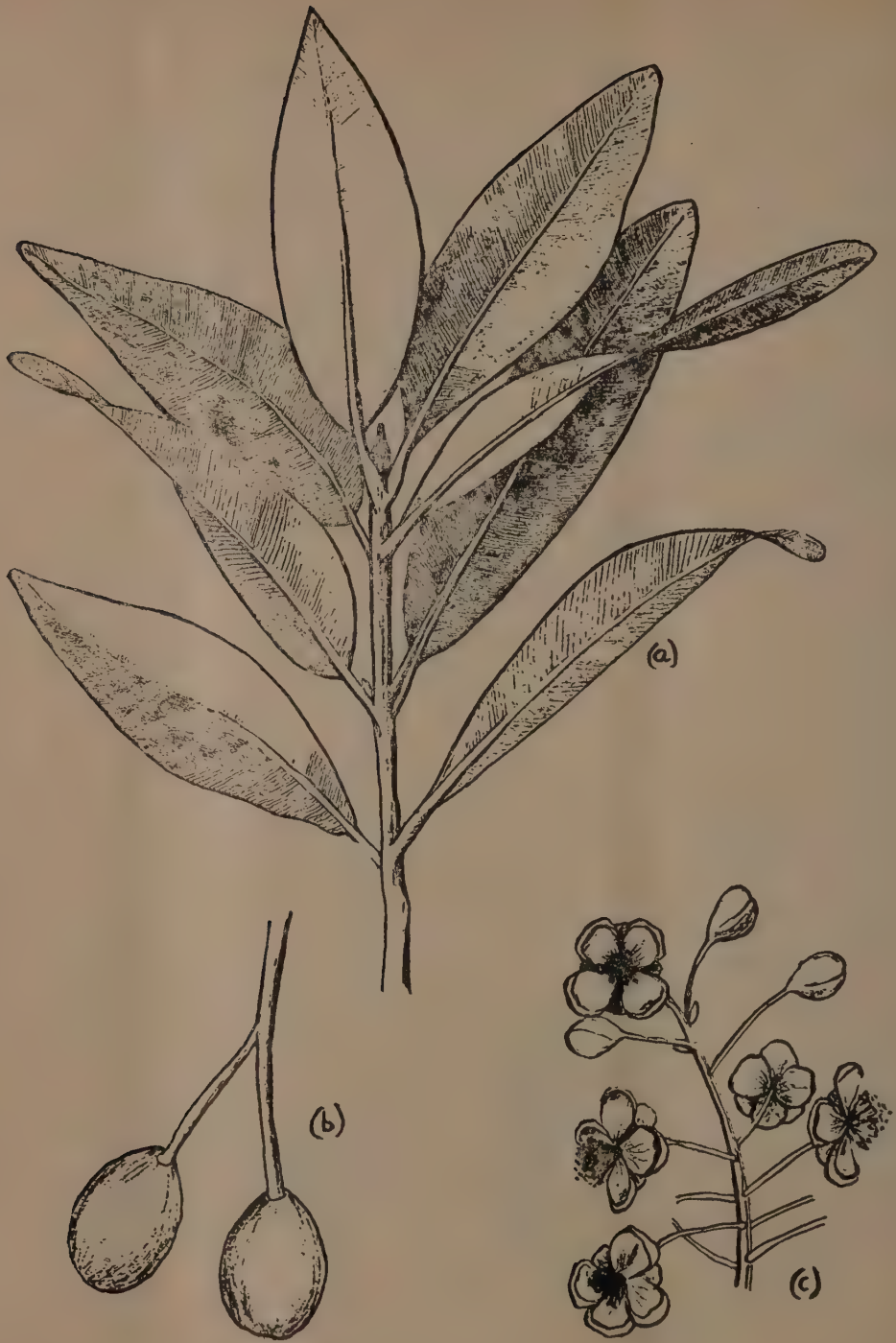
5. *Description of Timber*—There is a narrow band of greyish-brown sapwood surrounding a deep reddish-brown heartwood. The latter has prominent darker brown lines running through it resulting in an attractive figure. Grain is variable, often interlocked; texture is rather coarse with its numerous large pores being easily visible to the naked eye.

The timber is of medium weight, 36 lb/c. ft. dry, moderately hard and strong. Seasoning is difficult as there is a tendency to warp, twist and split, particularly in pieces showing irregularity in the grain.

Sawing of logs is not difficult, although those of the smaller sizes " spring " badly on the bench. Working of seasoned timber requires sharp tools, otherwise planing and chiseling may cause some trouble. The timber ' turns ' satisfactorily. Nailing of well seasoned timber is hard and although it holds nails well, it is liable to split. The timber is moderately durable in the ground, but if it is not in contact with the soil, it is resistant to decay, even in exposed positions.

6. *Uses*—Commonly used as a building constructional timber, both for internal and external use, e.g. weather boarding. Damanu is much easier to nail when unseasoned, so it is often used in this state for framing purposes which are held in place by the nailing. If it is to give satisfactory service, however, for such items as doors, door frames and sills, window frames and sills, jamb linings, etc., it must be well seasoned beforehand.

Fully seasoned, it also makes an excellent flooring, furniture and cabinet timber, although for easy working for these purposes, it requires machine tools, especially for sanding to a fine finish.



DAMANU—*Calophyllum vitiense* **Turrill (a) Leafy shoot ; (b) Fruit ; (c) Flowers**

KAUVULA Family : EUPHORBIACEAE

1. *Botanical Name : Endospermum macrophyllum* (Muell.—Arg.) Pax. & Hoffm.

Endospermum—from *endo* (within) and spermum (seed)

macrophyllum—from *macro* (large) and *phyllum* (leaf)

2. *Local Names*—Kauvula; Vula-vula; Lekutu.

3. *Distribution*—Widely distributed in most forest types from sea-level to nearly 3,000 ft. above sea-level, although it does not thrive in exposed sites. Best timber stands are in South-eastern districts of Viti Levu, but it is also common in certain other areas of the Colony, e.g. Kadavu. It is, however, generally sparse in Vanua Levu, where the greatest concentrations are in the Tunuloa district. The tree is an extreme light demander and is a coloniser in clear felled patches of forest, especially where the soil has been disturbed, as happens along logging tracks.

4. *Tree Description*—One of the tallest trees indigenous to Fiji, often exceeding 100 ft. in height and with girths occasionally reaching 15 ft.. Trees of 80 ft. height and 8–9 ft. girth are fairly common. It has a tall, clean but tapering bole, which is heavily buttressed at the base.

Bark is smooth in young trees, but older bark is slightly pitted and rough to the touch. It is greyish-white in colour, but sometimes has light green patches caused by mosses and lichens. Bark slash is yellowish-white and rather coarse-grained, with small reddish and white flecks. There is a copious sap flow from the slash.

Leaves are variable in that they may be either peltate or cordate on the same tree. Leaf tips are acuminate. Juvenile leaves from young trees are up to 12 inches in length and 9 inches in width and are borne on stalks of up to 9 inches long, at the top of which there are a pair of small green glands. Adult leaves from the bigger trees are usually about half the size of juvenile foliage. They are light green in colour, very slightly pubescent on the under-surface. Leaves are in terminal clusters with large leaf scars spirally arranged on the twigs below

Flowers are in creamy-white spike inflorescences, 2 ins. to 4 ins. long.

Fruits are round, $\frac{1}{4}$ in. diameter, succulent and yellow when ripe. They contain 3 cells or capsules, each containing a single black seed which is often empty or infertile.

5. *Timber Description*—There is a wide band of sapwood which often extends to near the centre, even in large trees. Heart and sapwood are creamy to yellowish-white in colour. Grain is generally straight; texture is medium to coarse. It is fairly light in weight, 30 lb/c. ft. dry, and not particularly hard or strong; this is particularly true of wood from near the centre of old trees. Logs are very easy to saw and the timber works easily with machine and hand tools. It has excellent nailing qualities. Tension wood is a feature in some Kauvula timber, and when present, it can cause considerable twisting and warping.

The wood is not at all durable, so should not be exposed to conditions inducing decay unless it has been previously impregnated with a preservative; it absorbs preservatives readily. Logs lying in the forest are liable to infestation by sap-stain fungi and by pin hole (*Ambrosia*) beetles. Sapwood, when dry, is very susceptible to powder post (*Lyctus*) beetle attack. The seasoning of the timber requires care, with proper stacking under cover being necessary if twisting, splitting and staining is to be avoided.

6. *Uses*—Although Kauvula has not been generally accepted by the timber trade, it has already been used by some people with a fair degree of success over a period of years. *If treated with an approved preservative and properly seasoned* the timber has great potential as a general utility timber in the Colony. It should find a wide use in housebuilding—for studs, top-plates, weather boarding, flooring, kitchen fittings, interior finishings, shelving, doors, etc. Stain free timber can also be used for furniture and it is particularly suited for making light furniture and accessories of modern designs.

The big advantage which treated Kauvula holds over many other timbers, including the imported Oregon Pine, is its resistance to decay and immunity from termite attack.

Unless it is treated with a preservative, Kauvula can only be used for temporary purposes, such as crates and banana boxes, although preliminary trials have indicated that the timber may also be suitable for the manufacture of match boxes and splints.

KAUVULA—*Endospermum macrophyllum* (Muell.—Arg.) Pax & Hoffm. (a) Leaf ; (b) Leaf arrangement on stalk ; (c) Underside of leaf showing pair of glands at top of petiole ; (d) Inflorescence ; (e) Fruits

THE PROPERTIES OF TIMBERS IN FIJI

By G. WATKINS*

Prior to the approval by Government of timber research as a major development project and the voting of C.D. and W. funds in 1961 to permit of its implementation, it was felt that a start should be made into an investigation of the properties of some of the Fiji timbers, in order to provide some sort of factual guide for architects, builders and other timber users.

This work represents the co-operative effort of the Forestry Department and the Public Works Department over the past 2–3 years. The machine and handworking tests were carried out by the Joinery Section of the Public Works Department under the supervision of Mr. E. Giles. The mechanical (strength) properties tests were made in the Public Works Department laboratory under the supervision of Mr. E. L. Bentley. The other tests and data are the work of the Research Division of the Forestry Department, and the whole project has been collated and written up by Mr. G. Watkins, Research Officer. Burns Philp (S.S.) Co. Ltd. kindly co-operated in the preservative permeability tests.

It must be emphasized that the information given here should be only regarded as indicative and as a comparative guide for those seeking factual data. The reasons for this reservation are that the tests were only made on a relatively small number of specimens from restricted source material. Secondly, the strength tests were carried out at varying moisture contents for the different species, and it was necessary to adjust the results obtained to a standard moisture content to give comparable uniformity to the figures. Thirdly durability tests are so far of brief duration only. In due course it is proposed, to publish data obtained from a wide range of specimens of different origins tested under uniform conditions, over an extended period.

Providing the limitations mentioned are recognized, this information is of value in that it does provide factual evidence obtained from specific comparable tests carried out under research conditions with a fairly wide range of Fiji timbers, representing many hours of careful work and endeavour on the part of all concerned with the project, working with limited funds and facilities.

J. R. ANGUS,
Conservator of Forests.

This publication summarises information already known on the properties of the timbers most wisely used in Fiji. Data on the timbers are given in tabulated form in Appendix I.

WORKING PROPERTIES

These cover such aspects as sawing and planing by hand tools and by machinery.

The properties given are based on the results of tests carried out by the Joinery Section of the P.W.D., Suva, on fully seasoned timbers. Dakua Makadre (Fiji Kauri) was adopted as the yardstick by which the various timbers could be compared.

Ordinary commercial machines were used in the tests, with cutter positions, speeds etc., as recommended by the manufacturers; hand tools used were maintained in a sharp condition.

STRENGTH (MECHANICAL) PROPERTIES

When the term 'strength' is used, it is usual to qualify it by indicating which kind of strength is meant; for example, strength in compression or bending. This is important when selecting a timber for any particular purpose which requires special strength properties. Thus, in beams, bending stresses have to be considered, whilst for pit props, compression parallel to the grain is an important factor.

*Assistant Conservator of Forests

When timber is in use, it is, in fact, often subjected to several strains or stresses at the same time. Generally, only one of these predominates in any one particular type of work. It is for this reason that we need to know the comparative strength values of a timber, and also, how the values vary between different timbers. However, even within the same species there are considerable variations in the structure and composition of its timber and these are reflected in the variability of its strength properties. The strength of any particular piece of timber is affected by a number of factors, including the locality in which the tree was grown, the way it was sawn from the log, and its position in the log. Defects such as knots, splits and spiral grain weaken the timber, whilst moisture content has a marked effect on the strength with green timber being decidedly less strong than seasoned timber.

Nevertheless, if certain safeguards are adopted during the collection of material for testing, and also during the tests themselves, it is possible to determine fairly reliable mean values for any one species.

The strength properties on which data are most often calculated are as follows:—

Fig. I.

(1) *Compression—Parallel to Grain. See fig. I*—This property is a measure of the ability of a timber to withstand crushing from loads applied on the end grain. It is probably the best single criterion of the overall strength properties of a timber; high resistance values to compression are indicative that the timbers are suitable for such purposes as short columns, posts and struts of fairly large sectional areas.

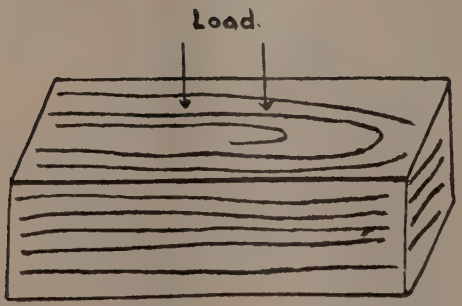


Fig. II.

(2) *Compression—Perpendicular to the Grain. See fig. II*—In this case, it is the ability of a timber to withstand crushing from a load applied at right angles to the grain which is important. High values for resistance to this type of crushing are necessary for sleepers, rollers, wedges, bearing blocks, bolted timbers, etc.

(3) *Shear. See fig. III*—This property is a measure of the resistance of the timber to forces acting on it which tend to make one part slide over another in a direction parallel to that of the grain. Shear strength data are useful when designing beams, especially short heavily loaded ones, when the depth is large relative to the length. It is also of importance when dealing with bolted timbers.

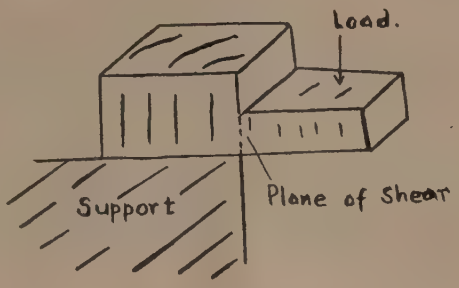


Fig. III.

(4) *Bending* (*modulus of rupture or equivalent fibre stress at maximum load*). *See fig. IV*—This property is a measure of the strength of a beam which is loaded slowly and continuously until it breaks. It is used in gauging sizes necessary for timbers subjected to transverse bending, such as joist rafters, beams, etc.

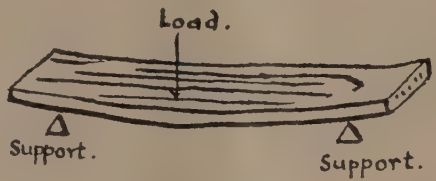


Fig. IV.

(5) *Stiffness* (*modulus of elasticity*). *See fig. V*—Timber under load may bend or deflect, and deflection is greater in timbers with a low modulus of elasticity: the greater the stiffness, the less the deflection. High values for stiffness are essential for joists, floor boards and other items which are not required to bend to any appreciable extent under load.

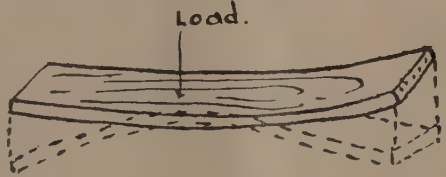


Fig. V.

(6) *Impact Bending* (*Shock Resistance*). *See fig. VI*—This measures the 'toughness' of a timber, or in other words, its ability to withstand sudden shock or impact loading. Timbers which snap easily under shock loads are said to be 'brittle'. A high shock resisting quality is essential for tool handles, athletic goods and certain vehicle and boat parts.

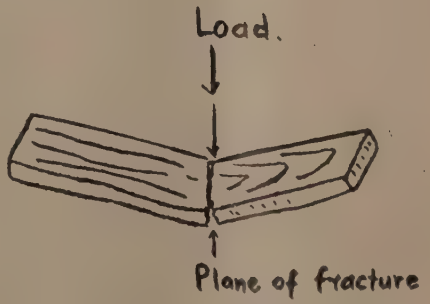


Fig. VI

(7) *Cleavage. See fig. VII*—This is the ease with which wood can be split lengthways. A resistance to cleavage is desirable when timbers have to be nailed. On the other hand, a low value for this property is of advantage when timber is to be split before use. Green wood splits more easily than seasoned wood, whilst if it has straight grain, splitting is easier than if it has twisted or interlocked grain.

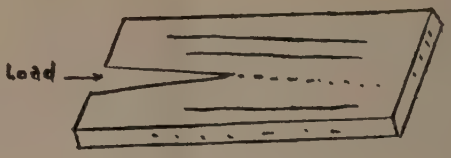


Fig VII.

LOCAL TESTS ON STRENGTH PROPERTIES

If reasonably true average values of the several strength properties of any one timber species are required, tests should be carried out on specimens obtained from a large number of different trees of that species. In the local tests, however, material for testing was limited; for tests on any one species, specimens were cut from three different trees, but as this number is insufficient to allow for possible variations within the species, the values obtained for the various strength properties cannot be regarded as true means. It is hoped, however, that until more accurate data become available, the results given here will serve as a guide to the strengths of the various timbers, and that they will be of some value when a general comparison is required. In addition, some published figures obtained from full scale tests for two well known imported timbers, viz., Oregon Pine and an Australian hardwood (Tallowwood), are given for comparative purposes.

With the equipment available locally, it was possible to conduct tests on only properties No's 1–4 above, viz., compression parallel and perpendicular to the grain, bending (modulus of rupture), and shearing. These were undertaken by the P.W.D. laboratory staff on a *California Bearing Ratio Soil Testing Machine*, which had been adapted for the purpose. The tests followed, as closely as facilities permitted, the procedure laid down for the 2 c.m. system in British Standards No. 373—1957, " Methods of Testing Small Clear Specimens of Timber ". A brief description of the tests that were made is given in Appendix II.

NATURAL DURABILITY

The following terms have been adopted to describe the length of life that can be expected from a piece of heartwood timber which is placed in contact with the ground:

(*a*) *Perishable*—Complete decay occurs within 6 months.

(*b*) *Non-Durable*—Decay occurs within 2 years.

(*c*) *Moderately Durable*—Remains free from decay for between 2 and 5 years.

(*d*) *Durable*—Remains free from decay for 5 years or longer.

5. Apart from Buabua, which is known locally to be extremely durable timber from practical experience, all other timbers have been classed as either *Perishable, non-Durable* or *Moderately Durable.* The timbers concerned have been classified on the basis of results obtained so far in the Timber Durability Testing Ground established by the Forestry Department at Colo-i-Suva during 1959.

With the continuation of these tests, it may be found that some of the timbers now classed as moderately durable will still be in a sound condition after 5 years. In the meantime, however, it is considered advisable to regard such timbers as moderately durable only. Local information on their durability is often conflicting, and unlike Buabua, there is insufficient evidence to justify placing any of them in the durable category.

It should be remembered that the classification refers to heartwood only, as the sapwood of most species is perishable unless given suitable preservative treatment beforehand.

PERMEABILITY TO PRESERVATIVES (WATER SOLUBLE SALTS BY VACUUM PRESSURE)

Preliminary trials on the absorption of Tanalith C preservative by timbers were carried out in a Tanalith Impregnation Plant.

Two specimens each of sap and heartwood per species were tested under normal commercial charges of Tanalith C at a concentration of 0·35 lb./c. ft., and at 200 lb. per sq. in. for 1 hour. The specimens were air-seasoned to below 25 per cent moisture content and they were also end-coated to avoid end-penetration complications.

These trials indicated that the majority of sapwoods could be treated satisfactorily.

Apart from Kauvula, however, heartwoods proved to be much more difficult to treat. In most cases, penetration of the preservative did not exceed $\frac{1}{8}$ of an inch after 1 hour's treatment. Longer treatments may have resulted in greater penetrations, but until such tests can be undertaken, the following classification has been adopted:—

(*a*) *Non-Permeable*—Penetration of preservative less then $\frac{1}{8}$ inch deep after 1 hour's treatment at 200 lb. per sq. inch.

(*b*) *Semi-Permeable*—Penetration variable but generally not exceeding $\frac{1}{4}$–$\frac{1}{2}$ inch deep after 1 hour at 200 lb. per sq. inch.

(*c*) *Permeable*—Penetration even and often complete throughout the timber after 1 hour at 200 lb. per sq. inch.

AVAILABILITY

An indication is given of the amount of timber present in the indigenous forests of the Colony as a whole. It does not follow, however, that the timbers are always cut by sawmillers and can be purchased easily from timber merchants in all the main centres.

Fuller details of the stocking and distribution of the timbers in various forests throughout Fiji are obtainable from the Conservator of Forests, Suva.

LENGTH OF BOLE

Average lengths of boles which are utilisable for conversion into sawn timber are given. In some areas, trees of exceptional sizes are encountered, so maximum lengths of boles that can be found are also quoted.

The lengths quoted were calculated from sawmill production returns and from enumeration data.

BORER (*LYCTUS*) SUSCEPTIBILITY

Seasoned sapwood of a number of species is highly susceptible to attack from *Lyctus* (the powder post beetle), although that of a few is immune.

The timbers which are known from local experience to be liable to *serious* attack from *Lyctus* are given the rating of *Highly Susceptible*. Timbers attacked, but in which damage does not assume serious proportions, are described as *Susceptible*.

Those believed to be completely immune are rated as *Non-susceptible*. This latter category includes Yaka, Dakua Makadre and Dakua Salusalu, which being *Gymnosperms* (Conifers), are definitely immune from attack. As regards some of the others, however, their non-susceptibility rating should be accepted with some caution until more authorative data become available. Starch tests, using Iodine/Potassium iodine reagents, gave positive results in a few cases, indicating that these may be liable to *Lyctus* attack despite local empirical information being to the contrary. In the hardwoods concerned, the sapwood is confined to a narrow band, so that in any event, *Lyctus* susceptibility is unimportant when such timbers are used for structural purposes.

Starch tests confirmed local opinion on the susceptibility of those timbers listed as Susceptible and Highly susceptible.

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APPENDIX II

PROCEDURE FOR STRENGTH TESTS ON LOCAL TIMBERS

1. *Compression—Parallel to the Grain*—A specimen 2 cm. x 2 cm. x 6 cm. is placed on a base plate with its grain perpendicular to the plate. A load is applied by a top plate approaching the bottom one. This load is applied at a uniform rate of 0·025 in. per minute until complete failure of the test piece occurs. The maximum load divided by the cross-sectional area in square inches is called the maximum crushing strength and is expressed in lb/sq. in.

2. *Compression—Perpendicular to the Grain* (1/10 in. *Stress*)—Test pieces consist of 2 in. cubes. A specimen is placed on a base plate with its grain running parallel to the plate. A load is applied by a top plate pressing on to the top surface of the test piece at a constant speed of 0·025 in. per minute. The load is applied until compression (or deflection) of the test piece reaches 0·1 in., at which point the stress, load divided by bearing area (sq. in.), is expressed in lb/sq. in. Tests are made on the radial and tangential surface of the specimens and the readings are averaged.*

3. *Shear Strength—Parallel to the Grain*—A 2 cm. cube specimen is held rigidly on a block fixed on to the bottom plate, but in such a way that it permits half of the specimen to be sheared off when a top load is applied. The top load is applied at a constant speed of 0·025 in./min. The tests are made in both the radial and tangential plane and the readings are averaged.

The load at complete failure, when shearing off occurs, is divided by the vertical projected area of the shear plane to give the maximum shear strength expressed in lb./sq. in.

4. *Bending (Modulus of Rupture)—Centre Loading*—A test piece 30 cm. long x 2 cm. x 2 cm. in section is supported in two places, 28 cm. apart. The ends of the piece are not restrained in any way, so that they are quite free to follow the bending action.

A load is applied to the centre of the test piece and on the tangential face nearest to the heart. It is applied at a constant speed of 0·025 inches per minute and it is continued until maximum load (or fracture) is reached.

The modulus of rupture is expressed lb./sq. in. and is calculated as the nominal extreme fibre stress at failure by dividing the maximum bending moment by the section modulus.

PREPARATION OF MATERIAL FOR THE STRENGTH PROPERTY TESTS

Apart from the Yasiyasi group of timbers, specimens for each of the various tests on any one species were obtained from three different trees of that species. For Yasiyasi, however, specimens were obtained from nine different trees, as specific botanical determination within this group is somewhat uncertain. There are at least two, and possibly three different kinds of Yasiyasi timbers, so a greater number of trees were selected to allow for possible specific variations in the group.

The specimens for testing were prepared from apparently defect-free timber. Heartwood was selected for all species, except in the case of Kauvula, where specimens were cut from sapwood which constitutes the bulk of the timber in the tree.

Moisture content is an important factor which affects the strength of wood. Reduction of moisture content from the green state to about 25%–30% results in removal of water from within the cell cavities, but this produces no apparent effect on the strength properties of most timbers. The conditions existing when the cell cavities are empty, but the cell walls are still fully saturated, is known as *fibre saturation point.* As drying continues below this point, the cell walls being to lose water, and as they shrink, there is an accompanying increase in most strength properties to a greater or lesser degree. Both maximum bending strength and maximum compressive strength increase considerably as the mois-

*In many tests on compression perpendicular to the grain, stress at the *Limit of proportionality* is calculated in addition to the stress at 0·1 in. This limit of proportionality is the stage when the amount of deformation in the specimen, caused by internal stresses set up by the load, ceases to be more or less directly proportional to the load. If the stresses (load) continue to increase beyond this point, the specimen will deform more rapidly until the fibres are severely crushed, when the stresses will build up again to an indefinitely high value.

Trade and Vernacular Name	Botanical Name	Availability within Forests	Length of Bole (Feet)		Machine Working		Hand Working				Nailing			Durability (Heartwood-ground Contact)	Permeability to Preservative (Pressure at 200 lb. per sq. in.)		Borer (Marine) Susceptibility (Dry Sapwood)	Ash-free weight (lb. per cu. ft., M.C. % in)	Strength Properties at 12% Moisture content—2 cm. Standard			
			Aver.	Max.	Planing, Sawing etc.	Turning	Sawing	Planing	Boring	Chiseling	Driving	Splitting	Holding		Sapwood	Heartwood		Percentage	Crushing (lb. per sq. in) Perpendicular to grain	Crushing (lb. per sq. in) Parallel to grain (max. crush.)	Shear (lb. per sq. in.)	Static Bending Coupon Load (lb. per sq. in.) Modulus of Rupture (Ave. No.)
Bauvudi	Burkella thurstonii	Limited	45	75	Very easy	Suitable	Easy	Easy	Easy	Easy	Easy	Slight	Fair	Non-durable	Permeable	Non-permeable	Highly susceptible	36 (18% m.c.)	1,000	7,400	1,000	9,000
Buabua	Fagraea gracilipes	Scarce	30	45	Easy	Not suitable (splits)	Easy	Difficult	Easy	Easy	Difficult	Bad	Good	Durable	Permeable	Non-permeable	Non-susceptible	68 (21% m.c.)	3,400	11,800	1,800	15,100
Dakua Makadre (Fiji Kauri)	Agathis vitiensis	Limited	50	75	Easy	Suitable	Easy	Easy	Easy	Easy	Easy	Slight	Fair	Non-durable	Permeable	Non-permeable	Non-susceptible	35 (18% m.c.)	1,020	6,180	1,000	9,000
Dakua Salusalu	Podocarpus vitiensis	Limited	40	60	Very easy	Suitable but soft	Easy	Easy	Easy	Easy	Easy	Slight	Very poor	Non-durable	Semi-permeable	Non-permeable	Non-susceptible	28 (14% m.c.)	660	5,280	1,000	7,700
Damanu	Calophyllum vitiense	Common	35	65	Variable, but generally easy	Suitable	Easy	Difficult	Difficult	Difficult	Difficult	Slight	Good	Moderately durable	Permeable	Non-permeable	Susceptible	46 (22% m.c.)	1,210	7,350	1,810	10,600
Kaudamu	Myristica castaniifolia	Abundant	45	75	Very easy	Suitable but furry	Easy	Easy	Easy	Easy	Easy	Nil	Poor	Perishable	Permeable	Non-permeable	Highly susceptible	37 (15% m.c.)	1,010	4,980	1,400	8,900
Kauvula	Endospermum macrophyllum	Abundant	40	90	Very easy	Suitable	Easy	Easy	Easy	Easy	Easy	Nil	Poor	Perishable	Permeable	Non-permeable	Highly susceptible	34 (18% m.c.)	1,210	6,550	1,600	10,300
Laubu	Garcinia myrtifolia	Limited	40	65	Easy	Suitable	Easy	Difficult	Easy	Easy	Difficult	Slight	Good	Non-durable	Non-permeable	Non-permeable	Susceptible	52 (18% m.c.)	1,800	8,530	1,900	13,000
Mavota	Myristica grandifolia	Limited	45	70	Very easy	Suitable	Easy	Easy	Easy	Easy	Easy	Slight	Fair	Perishable	Permeable	Non-permeable	Highly susceptible	41 (20% m.c.)	1,480	7,320	1,700	11,900
Rosarosa (Rogi, Savia)	Heritiera sp.	Limited	35	65	Reasonable	Suitable	Easy	Reasonable	Difficult	Reasonable	Hard	Bad	Good	Moderately durable	Non-permeable	Non-permeable	Non-susceptible	63 (18% m.c.)	3,270	7,300	2,300	14,000
Rosawa	Vitex vitiensis	Scarce	30	50	Easy	Suitable	Easy	Easy	Easy	Easy	Easy	Nil	Very poor	Moderately durable	Permeable	Non-permeable	Non-susceptible	44 (18% m.c.)	1,850	5,000	1,900	9,300
Sa	Parinarium insularum	Common	40	65	Reasonable	Suitable	Reasonable	Difficult	Easy	Easy	Hard	Bad	Good	Non-durable	Non-durable	Non-permeable	Susceptible	52 (18% m.c.)	2,250	11,800	2,200	13,300
Sacau	Sideroxylon sp.	Limited	35	60	Reasonable	Suitable	Reasonable	Difficult	Reasonable	Reasonable	Hard	Bad	Good	Moderately durable	Non-permeable	Non-permeable	Non-susceptible	58 (20% m.c.)	2,050	8,610	1,700	12,500
Tivi	Terminalia catappa	Limited	40	65	Easy	Suitable but furry	Easy	Easy	Easy	Easy	Reasonalbe	Slight	Poor	Non-durable	Non-permeable	Non-permeable	Non-susceptible	40 (18% m.c.)	1,210	6,950	1,800	11,100
Yaka	Dacrydium elatum	Limited	25	55	Easy	Suitable	Reasonable	Reasonable	Easy	Easy	Reasonalbe	Slight	Fair	Moderately durable	Semi-permeable	Non-permeable	Non-susceptible	42 (16% m.c.)	1,740	8,880	1,800	11,600
Yasiyasi	Syzygium sp.	Common	30	60	Reasonable	Suitable	Reasonable	Difficult	Reasonable	Reasonable	Difficult	Bad	Good	Moderately durable	Semi-permeable	Non-permeable	Non-susceptible	68 (18% m.c.)	3,040	9,610	2,300	15,200
														Moderately durable	Permeable	Non-permeable	Non-susceptible	34 (12% m.c.)	.....	7,170	1,500	8,200
														Durable	Permeable	Non-permeable	Susceptible	62 (12% m.c.)	2,540	11,200	2,200	20,000
Oregon Pine (Douglas Fir)	Pseudotsuga taxifolia	Imported timber from Canada.					Data from published sources.															
Tallow wood	Eucalyptus microcorys	Imported timber from Australia.					Data from published sources.															

ture content is reduced below 25%—as much as 4% to 6% increase in strength for each 1% reduction in moisture content. Stiffness (Modulus of elasticity) is affected to a lesser degree with approximately 2% increase in strength for a 1% reduction in moisture content. With toughness (impact bending), the reverse is true: there is a slight decrease in strength as the timber dries out below 25% moisture content.

For this reason, it is desirable for comparative purposes, for all strength values to be expressed at a standard moisture content. Most laboratories adopt 12% as their standard, but special conditioning chambers are necessary for the specimens to be maintained at this specification during the testing procedure. Strength values at 12% m.c can also be determined fairly accurately by conducting tests on green and air-dried material. There is a direct mathematical relationship between the strength values of green and dry timber, thus making it possible to calculate strength at 12% m.c. or at any other point below fibre saturation point.

Alternatively, approximate values for 12% m.c. can be obtained by the use of correction factors which adjust the various strength values for every one per cent moisture change in air-dry timber. This method has been employed for the determination of the strengths of the local timbers at 12% m.c., and average correction factors for Australian species were used for this adjustment as follows—

Compression : $\pm$ 5% per 1% change in M.C.

Shear : $\pm$ 3% per 1% change in M.C.

Modulus of Rupture : $\pm$ 4% per 1% change in M.C.

This standardisation of strength data to a 12% moisture content through correction factors gives approximate values only. It should be regarded, therefore, as an interim measure only, pending collection of data from full scale trials.

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ANIMAL HUSBANDRY . . .

A VALUABLE CONTRIBUTION TO THE POULTRY INDUSTRY OF FIJI AND OTHER ISLANDS

BY J. D. YELF

In 1949 the first day-old chicks were purchased by the Department of Agriculture and reared at the then newly-established Principal Agricultural Station at Koronivia; one hundred Rhode Island Red and one hundred White Leghorn chicks formed the foundation flocks. Subsequently there have been regular imports of eggs for hatching breeding cockerels to ensure the infusion of new blood.

Between 1950 and 1953 the Poultry section of the farm battled with kerosene incubators and development was further retarded by the hurricane of 1952; by 1954, however, the flocks had been increased to 800 birds and a 4,000 egg capacity electric incubator was installed. From then onwards the production of day-old chicks for sale has been an unqualified success.

Until quite recently the Station generated its own electricity and the supply at times gave trouble; this was overcome by an ingenious device fitted to the fan shaft of the incubator which rang a burglar alarm whenever there was a power failure; this alarm alerted the Farm Manager, whatever the time of day or night and the stand-by generator was duly started up. Even now that the Station has been connected to the main electricity supply, the alarm system is very useful in giving warning of power cuts so that the Station's standby engine can be started.

In 1958 a second 4,000 egg capacity incubator was installed; this considerably increases the number of chicks that can be sold during the hatching season which extends through the drier months of the year. Pullets hatched in this season come into lay from Christmas onwards when there is a shortage of eggs and when the old birds are likely to moult. If chicks are hatched too early in the year they tend to come into moult at the same time as the old birds, so it is important not to hatch too early.

The breeding birds are kept on the semi-intensive system, with 70 birds in each breeding pen which has two grass yards so that these can be rotated. Food and water are provided inside the houses so that during very wet weather the birds can be shut in. 1,200 hens are kept to supply the two incubators and this allows for a good selection of eggs for incubating.

SALES HAVE INCREASED YEARLY

The number of day-old chicks sold during the past 7 years is 98,349. This total, plus the surplus from the chicks kept for flock replacements, means that well over 100,000 young birds have been produced. This impressive out-turn has improved the poultry of the Colony very considerably as it has made it possible for the small farmer and the housewife to obtain good poultry without having to bother about importing. To start with, a price of 1s. 6d. per chick was charged for unsexed birds and this was increased to 2s. each in 1958.

The day-old chickens are packed in boxes holding 1,225 or 50 chicks and the orders which are to go to Nadi, Labasa, Taveuni, Samoa, Tahiti, or Tonga are taken to Nausori Airport where they are placed aboard Fiji Airways. Chickens have also been sent by sea to Fanning Island, shipped in a larger box which will allow feeding and watering en route.

TABLE 1

IMPORTS OF DAY-OLD CHICKENS TO FIJI AND PRODUCTION STATISTICS, KORONIVIA

Year	Imports from New Zealand and Australia	Chicks sold from Koronivia	Chicks kept for replacements	Total hatch
1954	10,982	9,000	4,355	13,355
1955	14,735	11,672	1,718	13,390
1956	23,099	10,849	2,251	13,100
1957	10,450	13,161	1,712	14,873
1958	29,199	17,330	1,896*	19,226
1959	28,020	16,780	2,496*	19,276
1960	51,405	19,557	2,734*	22,291
up to end of September, 1960				
Totals ..	167,980	98,349	17,162	115,511

*Mostly pullets kept for replacements. Replacement cockerels are hatched annually from eggs purchased in New Zealand.

The sharp increase in imports for 1960 is due to the local development of the broiler trade; the bulk of these imports comprises cockerels or cross-bred White Leghorn x Australorp pullets which are not obtainable from the Principal Agricultural Station at Koronivia.

In 1958 the services of a trained poultry officer were obtained and the sale of sexed birds was started; pullets have been sold within Fiji at 3s. 6d. each and cockerels at 1s. for Rhode Island Reds and 6d., for White Leghorns; this additional service has proved very popular and nearly half the total birds sold in 1960 were sexed, i.e. 4,777 cockerels and 3,094 pullets.

The rearing of cockerels is popular for sale to restaurants and hotels where the demand for quality poultry meat is increasing. Also, all races in Fiji eat poultry and there is a steady demand from housewives.

In the first few years of the project White Leghorns were the popular breed but during the last four years the sales of Rhode Island Reds have nearly doubled the sales of White Leghorns; this is because the Rhode Island Red makes a good table bird when its laying days are over. But the fact remains that the White Leghorn lays about two dozen more eggs per year than the Rhode Island Red and the value of these extra eggs is far more than the value of the extra meat carried by the Red bird.

CHICKS AVAILABLE FOR TERRITORIES OUTSIDE FIJI GROUP

The practice has been to hatch between mid-May and October when the best weather for rearing occurs. However, by starting incubation a little earlier in the year it is possible to increase production by several thousand chickens and thus be able to supply more chicks to other Island territories which have regular air services. The price per chick for export is increased slightly to cover the extra trouble involved in arranging special hatches and journeys to the airport.

In Fiji it is important that Government services pay for themselves as far as possible; in this respect the Poultry section of the Principal Agricultural Station has carried out a useful service and at the same time returned over £19,000 revenue over the past seven years.

CROSS-BREEDS—AN IMPROVED SERVICE TO THE PUBLIC

An egg-laying trial was carried out during 1960 with Cross-bred White Leghorn x Rhode Island Red pullets against pure bred White Leghorns and Rhode Island Reds. The results have been encouraging in that the cross-breds gave 29 per cent more eggs than the White Leghorns and 47 per cent more eggs than the Rhode Island Reds.

Admittedly, as the trial extended over the first six months of laying, the Reds were slightly at a disadvantage as they take longer to come into lay. As a result of this trial, and in order to keep up with the modern trend in egg production, crossbreds will be offered for sale during 1961; they are white or mixed brown and white in colour and combine the best points of both breeds; they lay more eggs than either of their parent breeds and they are nearly as heavy as the Rhode Island Reds, while they come into lay earlier and are less broody. The hybrid vigour makes the cross-bred cockerels grow quicker and thus they are bigger than the Leghorn cockerels and have a value for rearing for the broiler trade.

Cross-bred poultry, however, should only be used for egg production and not for breeding. It is the first cross which has the hybrid vigour stimulus to lay more eggs and this may be lost in the next generation. Farmers or housewives who intend to breed from their own fowls are advised to keep either pure Rhode Island Reds or White Leghorns. But hens kept in cages or semi-intensively purely for egg production can be cross-bred.

PREVENTION OF FOWL POX

In order to help prevent losses from fowl pox it is proposed that, from 1961 onwards, all day-old chicks sold from Koronivia will be vaccinated with pigeon pox vaccine which gives an immunity against fowl pox for the first 14 weeks. Customers who wish to extend this immunity will need to arrange to import fowl pox vaccine through a Veterinary Officer and to give the chicks a second vaccination at 12–14 weeks old; this procedure has been followed at Koronivia with excellent results. This service is one which many small farmers will appreciate as fowl pox can often cause serious losses in small chicks, especially if they are housed near adult birds.

THE FUTURE OF THE INDUSTRY

As the population continues to grow there must inevitably be a steady demand for more eggs and for more birds for the household and the small farmer; in addition the developing tourist industry will increase the demand for table poultry and eggs.

The Department of Agriculture in Fiji has greatly assisted the development of the poultry industry by making good poultry easily available to the farmer and the housewife. It is hoped that, by increasing egg production by cross breeding and by selling chicks already vaccinated with pigeon pox vaccine, the public will be even better served in the future.

N.B. The prices quoted are for the Colony of Fiji only. A slight increase is necessary to cover extra handling and special hatches to coincide with air transport to other countries. Enquiries should be addressed to the Director of Agriculture, Suva.

Agricultural Publication . . .

THE WEEDS OF FIJI

BY J. W. PARHAM

A bulletin describing the weeds of Fiji is on sale at the Department of Agriculture, Suva.

The bulletin contains botanical and general descriptions of most of the major and minor weeds of cultivation, pastures and wasteplaces in the Colony, together with notes on their distribution. About 90 of the most common weeds are illustrated by line drawings. The price of the bulletin is five shillings (Fiji currency) per copy.

Orders may be addressed to the Director of Agriculture, Suva.

The breeding flocks are housed in semi intensive houses with two grass yards to each house. Goats are run in to yards to ' mow ' the grass

Young stock are reared on free range and sheltered in arks with deep litter to mitigate fly nuisance

Day-old chicks are carried by air to other countries as well as islands in the Fiji group

PROMISING RESULTS IN THE BEEF PRODUCTION PROJECT

BY J. D. YELF

The Agricultural Department's programme for increasing beef production in the Colony by the use of Santa Gertrudis and Zebu bulls is beginning to show results. As pedigree bulls are expensive to procure overseas and are well beyond the means of most farmers in Fiji, bulls are being bred at the Agricultural Station, Sigatoka, for sale to farmers at reasonable prices.

Cross-breeding with Santa Gertrudis and Zebu cattle has resulted in a marked increase in the rate of beef production. This rate is still not up to the standards of the Argentine or the United Kingdom; but, with better grasses and some supplementary feed, there is no reason why Fiji should not be self supporting in beef and, as the ranges in the West are tamed and improved, might even produce a surplus for export.

The Colonial Sugar Refining Company Ltd. has tamed the hills at Yaqara and turned them into a fine ranch. Similar hills can also be tamed and cattle fattened on the better grasses which are being investigated by the Department of Agriculture. However, capital to develop the beef industry on a scale which will make ranches like Yaqara possible will have to be forthcoming if self-sufficiency—with possible export—is to be achieved. A commendable start has already been made on a small scale by a group of Fijians in the vicinity of Ba with the purchase of a small breeding herd of Herefords from the Colonial Sugar Refining Company Ltd.

In 1955 the Fiji Government purchased four Santa Gertrudis bulls from the King Ranch in Victoria. At that time it was not possible to get female stock of this breed from Australia or America so a breeding programme with Red Poll heifers was started on the Agricultural Station at Sigatoka and with Hereford heifers on the Colonial Sugar Refining Company's ranch at Yaqara. At the beginning of 1958 ten pure-bred Santa Gertrudis heifers were obtained from the United States of America; nine calves from matings with the bulls from Victoria were born in the first four months of 1960.

The Santa Gertrudis breed is noted for producing beef in a hot climate and this is why in Queensland at present the bulls are fetching high prices.

Results so far in Fiji have been very promising and the off-spring sired by the Santa Gertrudis bulls at 2 years old are superior to pure bred Herefords of the same age under the climatic conditions of the dry zone in Fiji.

The steers were selected as fit for slaughter by the ranch manager and the general impression of the carcasses by the butchers was that the Santa Gertrudis cross-bred steers had less waste fat.

Steers Nos. 1 and 2 were not fully finished and did not have a full covering of fat along the whole side. Steers No. 8 and 21 were too fat. The best steer killed was No. 20 which despite its weight had grown so quickly that it was still not too fat. The carcass was 871 lb. at only 3 years 5 months old.

The amount of surplus fat which could not be sold from Hereford carcasses in one butcher shop was 9·2 per cent of the total carcass weight. There is not this wastage with the Santa Gertrudis cross-bred steers which mature 6 or even 10 months earlier than the Herefords. This earlier maturity is probably due to some hybrid vigour and the finer coat which the cross-bred cattle derive from the Santa Gertrudis.

Seven cross-bred Santa Gertrudis x Hereford steers selected at random from the fattening herd weighing between 750–800 lb. live weight gained an average of 1·2 lb. per day over a three month period May–August which is in winter when the Nadi blue grass *Dichanthium Caricosum* has seeded and is at its worst. The best weight gain was 2 lb. per day which is excellent for steers of this age on winter pasture.

AGES AND CARCASS WEIGHTS OF SANTA GERTRUDIS CROSS-BRED STEERS COMPARED WITH PURE HEREFORDS

Description of steer	Age		Live wt. lbs.	Hot Dressed wt. lb.	K.O %
	Yrs.	mths			
Killed 16/8/60—					
1 S.G. x Zebu Shorthorn No. 16 ..	3	8	horns too big for scale	675	....
2 S.G. x Redpoll No. 6	4	3	1,248	663	53·0
3 S.G. x Hereford No. 505	4	2	1,470	807	55·0
4 S.G. x Hereford No. 504	4	2	1,393	757	54·0
Killed 14/3/61—					
5 S.G. x Shorthorn No. 14	4	5	1,358	745	54·8
6 S.G. x Redpoll No. 20	4	0	1,355	718	53·0
7 S.G. x Redpoll No. 22	3	9	1,392	769	55·2
8 S.G. x Hereford No. 501	4	10	1,530	915	59·9 too fat
9 S.G. x Hereford No. 522	4	6	1,358	811	59·7
Killed 21/3/61—	3	6	1,450	792	54·6
10 S.G. x Hereford No. 556					
11 S.G. x Hereford No. 534	4	0	1,507	800	53·0
12 S.G. x Hereford No. 519	4	6	1,563	878	56·1
13 S.G. x Hereford No. 518 ..	4	6	1,422	774	54·4
14 S.G. x Zebu Shorthorn No. 15 ..	4	5	1,172	672	57·3
15 S.G. x Redpoll No. 9	4	8	1,432	803	56·0
Killed 25/4/61—					
16 S.G. x Hereford No. 547	3	10	1,402	802	57·2
17 S.G. x Hereford No. 565	3	5	1,183	663	56·0
18 S.G. x Hereford No. 510	4	10	1,560	896	57·5
19 S.G. x Redpoll No. 17	4	4	1,222	689	56·4
Killed 15/8/61—					
20 S.G. x Polled Hereford No. 574 ..	3	5	1,512	871	57·6
21 S.G. x Hereford No. 514	4	11	1,414	818	57·7
22 S.G. x Hereford No. 554	3	10	1,150	649	56·4
23 S.G. x Hereford No. 530	4	6	1,225	664	52·2
24 S.G. x Hereford	3	10	1,297	746	57·5
Average age	4	2	Average carcass	762	....
25 Pure Hereford for comparison ..	By dentition 4	0	1,330	772	58·0
26 Pure Hereford for comparison ..	By dentition 4½—5	0	1,450	829	57·1
27 Pure Hereford for comparison ..	4½	0	.....	772	....
28 Pure Hereford for comparison ..	5	0	1,253	721	57·6
29 Pure Hereford for comparison ..	4½—5	0	.....	705	....
Average age by dentition ..	4½—5	0	Av. carcass	759	

It is realised that these are only the first few cattle but, judged by the growth and weights of the remainder of the herd, the policy of cross breeding with Santa Gertrudis bulls is indeed promising. It should be noted that the Santa Gertrudis cattle cross very well with any large type of dairy cow or large nondescript cow with some Zebu blood in it.

The average weight of 23 half bred Santa Gertrudis x Hereford cattle at two years old was 737 lb. and the average weight of 5 Santa Gertrudis x Cross bred Zebu cattle was 679 lb. Breed for breed Santa Gertrudis cattle have been found to weigh more than 150 lb. heavier than pure Herefords of the same age. The Department, in co-operation with the Colonial Sugar Refining Company, is still keeping growth records of these cattle.

At the time the Santa Gertrudis cattle were introduced there was some doubt as to the value of the introduction, since this breed is very expensive to purchase, both in America and Australia; however, it can be now seen that beef will be produced quicker by the use of Santa Gertrudis bulls and this may well mean that beef steers will be ready for slaughter in three years instead of in four or five years. In this connection it should be noted that the Argentines get their beef animals ready in 2½ years to produce 600 lb. meat.

The Department of Agriculture has introduced may new grasses into Fiji and it is hoped that, with better feed and better breeds of beef cattle, the importation of beef will be unnecessary. It must be appreciated that the number of working bullocks will decrease as the number of tractors increases; this means that beef will have to be specially reared.

The Department has also a very fine herd of beef Zebu cattle at Sigatoka and the bulls from this breed, like the Santa Gertrudis, cross well with large cows of other breeds to produce beefy calves which grow faster than ordinary cattle. They also produce very fine working bulls which still command a good price.

All the Santa Gertrudis and Zebu bull calves which are likely to be born within the next two years have been booked for farmers who wish to improve their herds of beef cattle.

There is one point which is still not clear and that is whether the pure Santa Gertrudis cattle will do as well in Fiji as the cross-bred animals which, no doubt, owe their superiority to hybrid vigour. Certainly the pure Zebu cattle are not as good as their cross-bred off-spring and thus the Department intends to sell pure-bred bulls to ensure that this hybrid vigour is still maintained. Even though the half-bred and three-quarter bred offspring look very fine one cannot expect to get as good results by using them as bulls. It is for this reason that no half-bred bulls will be sold and only a limited number of selected three-quarter bred bulls will be available.

The Burns Commission noted that there were some very fine large animals around Fiji and suggested that the introduction of Santa Gertrudis was unnecessary; but these large cattle are generally fairly aged by the time they reach their full size or they are the off-spring of Zebu bulls and dairy cows so that their size is mainly due to the hybrid vigour. Breeding from half-breds or slow maturing stock is not likely to produce the effect of early maturity and thus quicker beef production, such as can be obtained by using pure Santa Gertrudis or Zebu beef bulls on large cows. This policy could, in time, result in the development of a fixed beef breed in Fiji, but this takes many years and the meat is needed now. The policy of cross breeding to get hybrid vigour and thus bigger yields is carried out with poultry and with crops such as maize and rice; from observations on the off-spring of the Santa Gertrudis and Zebu bulls it is giving the increase in beef that is being sought in Fiji. So, though initially the expense may seem high, if every beast from these Santa Gertrudis or Zebu bulls produced only 50 lb. more meat in 4 years than the present local stock it will not take long to repay the cost of importing the bulls and heifers; the return may not show up as direct revenue but in the increase in meat production in the Colony and a corresponding reduction of imported meats.

As better beef becomes available there could well be a better price to the farmer for cattle which have been specially bred as beef in contrast to the old dairy cows or working bulls which provide the bulk of the local meat at present.

There is a future for beef ranching in the drier parts of Fiji; if more capital were invested in this enterprise land which is at present useless would become productive and a useful export industry might result.

ACKNOWLEDGEMENTS

Facilities for weighing and slaughtering the cattle were kindly provided by the Colonial Sugar Refining Company and special thanks are due to the Yaqara Ranch Manager Mr. Holboro.

Half-breed and three quarter-bred Santa Gertrudis X Hereford at one year old

The first pure bred Santa Gertrudis calves born in Fiji. Their sire came from Victoria and their dams from Texas

A rib from a half-bred Santa Gertrudis X Hereford steer aged four years and four months. Note good fat cover over whole rib and good marbling

ENTOMOLOGY . . .

A SHORT HISTORY OF SCOLIA RUFICORNIS, PARASITE OF ORYCTES SPP.

BY H. W. SIMMONDS, O.B.E.

When it was found that manual methods against the Rhinoceros beetle (*Oryctes rhinoceros*) in Samoa had proved useless, the German Administration of that date engaged Dr. Karl Friedericks to undertake a world search for such biological agencies as might check the ravages of the pest, but the outbreak of war in 1914 put an end to his researches. At that time, after an unsuccessful search in Southern Asia, he was proposing to attempt obtaining a Scoliid, *S. oryctophaga* of Madagascar, a parasite known to be capable of breeding upon more than one species of *Oryctes*.

In August, 1933, I was seconded to Samoa to make a general report on the position and, arising out of that report, I was asked, after my retirement from the Fiji Service in 1937, to follow up Friedericks' work, making a tour of Java and Malaya, looking for such agencies as might be found there which it was thought might be of value against the pest if transported to Samoa and, more particularly, to investigate a suggestion that *Scolia ruficeps* of Malaya was a true parasite of the beetle.

As the Dutch in Java were reported to be breeding *S. oryctophaga* upon *O. rhinoceros*, I was asked to try to obtain a colony of this parasite from them and despatch it to Samoa. On arrival there, however, I found that they had been unable to maintain their colony and it would thus not be possible to obtain a colony from this source. I also began to suspect that this species would, for climatic reasons, not be suitable for Samoa, a suspicion which was strongly supported when I came to study the records of its appearance in Mauritius, where it had been introduced a number of years previously.

From Java I went on to Malaya, where all efforts to induce their *S. ruficeps* to attack *Oryctes* proved fruitless. In this connection, however, there is in Burma a more robust form of *ruficeps* which may use a larger grub, such as *Oryctes*, as host.

A large number of adult beetles was dissected in a search for Tachinid parasites, but none were found, and the only likely predator seen was a Carabid, *Catascopus facialis* Wied., a colony of which was shipped successfully to Samoa, but which does not seem to have established itself.

As my instructions were that, should I not find anything of value in Malaya, I was to go on to Mauritius and Madagascar and endeavour to obtain *S. oryctophaga*, I felt that the time had come to so, although I was not very optimistic about the result for the climatic reasons mentioned above, although it had been definitely shown in Java to be capable of using *O. rhinoceros* as its host.

It was not until August of that year, 1939, that the first adults of the wasp appeared, i.e. at the end of the cool season. I therefore left my wife in Mauritius to collect there whilst I went on to Madagascar to obtain further supplies. A total of about five hundred females was obtained from the two sources, the majority of the Madagascar ones being forwarded by air, incidentally catching the last 'plane from Alexandria before the outbreak of war, whilst as there was, at that time, no air service from Mauritius, we had arranged to accompany the balance by sea. Although both consignments reached Samoa in good order, the wasp failed to make good, a report that one had been seen a year later being the only probable record. Whilst I had been in Mauritius, an officer of the Department of Agriculture there, Moutia by name, had informed me that, in the Zanzibar Museum, *Scolia carnifax* was exhibited as being a parasite of one of their species of *Oryctes*; as this wasp was also present in Mauritius I was able to test it on their *O. tarundus*, but it was not interested. However, it had to be investigated and we arranged that my wife should accompany the *S. oryctophaga*, whilst I left the ship at Zanzibar and went into the matter. However, as soon as I saw the

Museum specimen I realised that it was not *carnifax*, but as war was then inevitable, I felt it wiser to on with the *oryctophaga* colony and try to get them through. I did, however, manage to capture several females of this Scoliid, which proved to be *S. ruficornis*, and tested them out on the ship upon East African *Oryctes* grubs. I then found that it was truly parasitic upon them, going through its stages from egg to hardened cocoon in the remarkably short time of nine days. This did not, however, mean that it would definitely be able to use *O. rhinoceros* as its host, and, as war had already broken out before we left the African coast, I had much difficulty in obtaining a few beetle grubs of the Asiatic species when we reached Singapore. However, I did obtain about half a dozen. Tests with these were inconclusive; the parasite stung them freely and most of them lived long enough for the parasite to develop, but I only obtained two eggs, one of which was infertile whilst in the other case the host grub died when the parasite larva was only half grown. Whilst this could have been that the parasite sting was too severe, it seemed to me more possible that the salivary juices of the parasite larva might prove poisonous to its proposed new host. I therefore had to advise the Samoan Administration that, whilst climatically *ruficornis* seemed suitable for Samoa, its introduction would be a gamble, although, in my opinion, a good gamble. When three years later it seemed definite that *oryctophaga* had failed to establish itself, I was asked to try to establish *ruficornis*.

When I left Melbourne for Zanzibar we were still at war with Japan, but a limited air service had been commenced via Colombo. Shipping was, however, very irregular and, on arrival at Cape Town, I considered it advisable to travel overland to Dar-es-Salaam, whence I was able to cross to Zanzibar Island in a small ship flying the flag of the Sultan of that Island.

Acting on the advice of London, supported by my own judgement, I forwarded the first few weekly consignments of adult females via the United States of America, but the results were most unsatisfactory, one consignment never arriving and there being only one survivor in a second. I therefore changed over to the Ceylon route with most satisfactory results, so that, of the total of nearly a thousand females shipped, including those lost via the United States of America, about fifty per cent arrived in Samoa in good order.

Following this, the American Administration in the Palaus decided to obtain a colony from the same source for those islands. For a long time the results in both cases were doubtful, but, three years after they were first released in Samoa, they appeared in numbers some twenty-six miles from their point of liberation.

The story from the Palaus is much the same, but there they obligingly appeared close to the Entomological laboratories of the Department, where the officer doing the work discovered that the parasite normally made its cocoon a foot or more down in the soil, below the compost in which the beetle grub lived. This fact was of great interest to me because I had been able to find very few cocoons in the heaps at Zanzibar, where I had collected nearly a thousand female wasps.

Meanwhile the Rhinoceros beetle had invaded Fiji and, by the middle of 1958, it was considered to be in sufficient numbers to provide the necessary grubs to justify introducing the parasite. In this the authorities in the Palaus, where it was now breeding in numbers, where most helpful, sending us a colony of 232 cocoons, and the work of breeding from these was commenced immediately at Dravo, near Bau.

As the beetle was confined to the one island of Viti Levu and the main coconut portions of the group were still free, it was imperative to take every precaution not to allow the escape of adult beetles from the parasite nursery and thus increase the risk of spread. To this end, the compost in which the grubs were placed for parasitisation by the wasp was placed in boxes about 3 ft. x 3 ft. 6 in. x 12 in. deep, and, after about four weeks, closed with a lid of half-inch mesh wire netting. Two or three weeks later these were opened and the enclosed compost put through a sieve. As the wasps could not go lower than the bottom of the boxes it was easy to collect

any cocoons present, which were then placed in separate heaps and covered with a foot or more of compost, where they could emerge and carry on.

Owing to what one might call the "homing instinct" of the wasps, the method worked fairly well, although many of the wasps must have travelled right away from the original nursery. They had, however, considerable difficulties to meet, since practically all the saw-mills are treated with B.H.C. which would be absolutely fatal to any wasp entering after beetle grubs, whilst most of the village rubbish dumps anywhere near the nursery go down into water.

In the nursery, breeding has gone on reasonably well and it has been possible to release several colonies in other localities, the first, consisting of 126 cocoons, being placed at Raralevu on the 11th November, 1958, followed by another of 77 cocoons in the following February at Deuba, whilst on the 3rd December, 1959, a colony of 115 cocoons was placed at the saw-mill at Wainadoi and on the 5th of May, 1960, the lastest colony of 106 cocoons was put out at Korolevu in the Tailevu. This is the most hopeful colony, since there is much beetle damage in the district and it is not so wet as Wainadoi, whilst the Deuba colony was washed away in a storm, but not before a considerable number of the adults had emerged.

Several difficulties have been met with. One of the most serious is that the parasite goes through a diapause, i.e. a resting period prior to pupating; this can last many months, during which it suffers heavy mortality. It now becomes apparent that it is to a considerable extent seasonal, and the object of the diapause is probably to carry it over an unfavourable period, the indications being that there are two or more generations in the year, a quick one followed by one with a prolonged diapause.

Of enemies in Fiji few have been met with so far, but mites are now causing losses in the Dravo nursery whilst the Wood Swallow was, on one occasion, observed taking the adults on the wing. Bulbuls were also suspected of picking up adults which had settled on the ground, a habit which the Kingfisher seems to have in the Palaus.

Looking to the future, it is hoped to have this parasite sufficiently established and widely spread so that, if and when the present manual methods become uneconomical, it will be there to assist the other environmental factors in keeping the pest within economic numbers.

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The Transactions of the Fiji Society cover a wide range of subjects including anthropology, botany, ethnology, geology, history and zoology, with special reference to the research carried out in Fiji and in other Pacific areas.

Volume 5 of the Transactions of the Fiji Society covers the years 1951 to 1954. Volume 6 of the Transactions brings the publications of the Society up to the end of 1957. Volume 7 will be available about the middle of 1953. The price per volume is twenty-five shillings (25s.) Fiji currency and this includes postage. Please note that one pound Fijian (£1.F.) is approximately equivalent to two dollars fifty cents ($2.50) U.S. currency.

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Orders should be addressed to the Hon. Treasurer, Fiji Society, P.O. Box 358, Suva, Fiji.

INSECTS ON YOUNG COCONUT PALMS IN FIJI

BY ALDEN D. HINCKLEY

During coming years there may be extensive replanting in the copra producing areas of Fiji, and it will be increasingly important to recognize the insects found on young coconut palms. Some of the most common species are described in this article, with recommendations for the control of those which may be harmful to palms less than 10 years old.

The Flat Moth, *Agonoxena argaula* Meyrick.

The adult of this species is sometimes seen resting on the underside of a frond, usually right next to the mid-rib of a leaflet. It is about 1/4 of an inch long and strikingly flat. Its colour is yellow-brown, the female being distinguished by a white stripe on each wing. Eggs are laid, singly or in rows, on the underside of the frond. When the caterpillar hatches, it is 1/10 of an inch long and after a series of 4 moults, reaches the length of 3/5 of an inch. In colour, the caterpillar is basically yellow, but ingestion of plant material gives it a greenish hue. It feeds beneath a silken tent, usually on the underside of the leaf, sparing the opposite side, and leaving elongate brown scars. When forced out of its shelter, the caterpillar moves rapidly over the surface of the leaf, sometimes wriggling off the leaf and lowering itself to the ground on a silken strand. The cocoon spun by a fully-fed caterpillar is an oval sheet of paper-like silk, 3/5 inch by 1/4 inch, found on leaves of plants beneath the palms as well as on the fronds themselves. The pupa, formed within the cocoon, is 1/4 of an inch long, dark brown, and slightly flattened. (Singh, S.R., 1952).

Throughout Fiji, damage to young palms by caterpillars of the Flat Moth is greater than that done by any other insect. A frond is attacked from the time it unfolds, and, after a year, it may have lost as much as 20% of its surface. Fungi add to the damage, entering the leaf through the feedings scars, while wind action splits the leaflets along the weakened lines.

Much damage is prevented by small wasps which parasitize the immature stages of the Flat Moth. Species of *Agathis*, *Apanteles*, *Bracon*, and *Macrocentrus*, the latter having been introduced from Java, attack the larvae. At least one species of *Brachymeria* develops within the pupae. The small, white cocoons of the native larval parasites are frequently seen on the fronds. Unfortunately, the parasites themselves are attacked by hyperparasites, thus reducing their effectiveness.

Treatments that accelerate the growth of young palms serve to reduce the percentage of leaf surface destroyed by caterpillars of the Flat Moth; such treatments, comprising good drainage, regular weeding, and application of fertilizers are therefore recommended. If immediate reduction of a heavy infestation (one or more caterpillars for every three leaflets) is desired, malathion 50 per cent emulsion at one ounce to three gallons of water can be sprayed on the lower surface of the fronds. The rate of application depends, of course, on the size of the fronds, but one pint should easily cover a one year old palm.

Mealybugs, *Pseudococcidae*

Insects of this family are characterized by their white, waxy covering. Those feeding on coconut palms are usually found inside leaf bases or on the lower portions of emerging fronds. Mealybugs are often attended by ants, which remove their exudations, transfer the mealybugs from plant to plant and possibly protect them from natural enemies such as ladybird beetles and lace wing flies.

The damage resulting from mealybugs sucking the sap from palms has not been fully evaluated. Yellowing of tissue occurs and growth may be slowed, but apparently no wilting toxicants are injected. Since the heaviest infestations are often on palms growing under poor conditions (Simmonds, H. W. 1938), the good cultural practices recommended for lessening flat moth damage are also useful in reducing mealybug damage. Any treatment that causes the leaves to unfold rapidly should help. It is also possible to kill the mealybugs by using

malathion 50 per cent emulsion at one ounce to three gallons, or, for very dense infestations, diazinon 20 per cent emulsion at two ounces to three gallons. Since only the leaf bases need be sprayed, one pint of spray should be enough to treat four palms.

The Coconut Scale, *Aspidiotus destructor* Signoret

The soft, yellow body of this small insect is covered by a semi-transparent scale which can be lifted off with a pin. At maturity, the male scale is oval in outline and the female is nearly circular. However, while the male changes into an active winged form, the female becomes a shrivelled lump surrounded by white or yellow eggs. The "crawler" which hatches from an egg wanders over the leaf surface for a few hours, then inserts its beak, and does not move for the duration of its development. (Taylor, T.H.C., 1935).

The Coconut Scale was a major threat to coconut palms in Fiji from 1912, when it was first noted on Viti Levu, until 1929, when it was controlled by a ladybird beetle, *Cryptognatha nodiceps* Marshall, introduced from Trinidad. The ladybird beetle is still quite effective in most situations. However, the scale can sometimes reach high densities on a young palm before the ladybird beetle finds the infestation. In such cases, the fronds become coated with scales, especially on the underside. There is also the possibility of outbreaks caused by the misuse of certain insecticides. DDT, for example, is known to be far more deadly to ladybird bettle than to scales, so it should not be used to control scale infestation. If it is necessary to use insecticides to control scales on young palms, diazinon 20 per cent emulsion, one ounce to three gallons, at one pint to a palm should be safe and effective.

Rhinoceros Beetle, *Oryctes rhinoceros* (Linnaeus)

Although it usually attacks older and taller palms on Viti Levu, the rhinoceros beetle could be damaging to young palms in areas where there are no tall palms. One beetle, making its characteristic attack on the growing tip, could easily kill a year-old palm. See (6) and subsequent articles by O'Connor.

Stick Insect, *Graeffea crouani* (Le Guillou)

These brown or green insects chew notches along the edge of a leaflet. In the copra-producing areas, they sometimes damage young palms interplanted with old ones. Previous articles covering their biology (O'Connor, Pillai and Singh, 1954) and control (O'Connor, 1959) have appeared in this Journal.

Derbid Leafhoppers, *Derbidae*

More than six different kinds of derbid leafhoppers have been observed on young palms in Fiji, usually resting on the underside of fronds. They range from 3/16 to 5/16 of an inch in length and resemble small moths. The most common is a black and white species, *Pyrrhoneura saccharicida* Kirkaldy, which rests with its wings in a horizontal "V". Another species, *Swezeyia lyricen* Kirkaldy, has a reddish-brown band on each forewing. Others, *Paralyricen* spp. and *Flaccia* spp., are all white or speckled with brown.

The nymphs of derbids feed on fungi in rotting vegetation, but the adults suck some sap from palms and other plants. No injury has been attributed to the leafhoppers other than small yellow spots at feeding punctures made by the adults. Only if it were shown that the derbid leafhoppers injected a toxin or transmitted a pathogen would it be desirable to control them.

Cluster Caterpillar, *Prodenia litura* (Fabricius)

This pest, although it attacks leaves of many different plants, does not feed on the coconut palm. It is mentioned here because its eggs are often found on the fronds of young palms. The eggs are laid in a mass from 1/2 to 1 inch long and 1/4 to 1/3 inch wide on the underside and near the tip of a leaflet. The mass is covered by a tan, fur-like material and usually contains well over 100 grey eggs. Sometimes tiny grey caterpillars with black heads can be seen swarming out of a mass.

Green Lacewings, *Chrysopidae*

Green lacewings are sometimes found on young palms, feeding on eggs of the cluster caterpillar moth, or on aphids, scales, and mealybugs. The adult has transparent,

paddle-shaped wings and a wing-spread of up to one inch. Green lacewing eggs, found on the upper side of leaflets, are quite distinctive, each being supported by a thin, silken stalk. The predatory larvae can be recognized by their large, sickle-like jaws.

Praying Mantis, *Tenodera costalis* Blanchard

The Praying Mantis, a generally beneficial predator, is another insect which lays its eggs on the fronds of young coconuts. The egg mass is made of a porous and papery substance, roughly in the form of a cylinder 3/4 inch in diameter and 1/2 inch in height. More than 50 brown nymphs, each $\frac{3}{8}$ inch long, emerge from the egg mass. Adult females are about three inches long with a wingspread of four inches. Both nymphs and adults of the praying mantis have some resemblance to the coconut stick insect but can be distinguished by their grasping forelegs.

Ladybird Beetles, *Coccinellidae*

Beetles in this family are best recognized by their dome shape. The most common species on young palms is *Anisorcas affinis* Crotch. It is 1/10 of an inch long with a glossy black body and red head. *A. affinis* sometimes feeds on scales but it is so often found on palms apparently free from scales that it may be able to subsist on other food. A ladybird beetle about the same size as *A. affinis*, but found only on scale infested trees, is the famous *C. nodiceps*. It usually has a light coloured line along the outer edge of its wing covers and orange markings down the centre of its back.

Two other species of ladybird beetles have been observed attacking mealybugs on young palms. One, introduced from Austtalia in 1924, is *Cryptolaemus montrouzieri* Mulsant, about 3/16 of an inch in length and black with red-brown markings. The other, *Archaioneda tricolor fijiensis* Crotch, is the largest ladybird beetle in Fiji, 5/16 of an inch long and coloured brown or orange.

Earwing, *Chelisoches morio* (Fabricius)

This earwig is a general predator and scavenger, commonly found at leaf bases and between leaf folds on young palms. It is glossy black and may reach a length of 3/4 inch. On the end of its abdomen are a pair of large forceps used in holding its food.

Ants, *Formicidae*

On young palms in Fiji, ants often attend scales and mealybugs, and certain species may also attack soft-bodied or unprotected insects. Among the species observed: one with large-headed soldiers, *Pheidole megacephala* (Fabricius); one in which all castes are black-headed, *Tapinoma melanocephalum* (Fabricius); and one with light-brown feet, *Technomyrmex detorquens* (Walker).

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RURAL INDUSTRY

BEE KEEPING

BY G. B. GREGORY

This article is not intended to serve as a treatise on bee-keeping; it is hoped that, by presenting the story of bee-keeping in simple language, some interest may be aroused in the subject and a few people in Fiji encouraged to try their hand at what can well prove to be an absorbing and profitable hobby, sideline or, perhaps in due course, whole-time occupation.

HONEY AND BEESWAX

Honey is the sugary liquid produced by the honey bee *Apis mellifera*, and is an important article of world commerce; it is manufactured by bees from the nectar which they collect from the flowers of a wide range of plants, both wild and cultivated.

Beeswax is a substance produced by special glands in the body of the honey bee; it is not manufactured from the pollen or waxes collected from the flowers but is a product of the digestive processes of the honey bee. Beeswax is produced in the form of minute scales which the bees chew and shape into comb from which their nests are made and in which they raise their young and store their honey.

The knowledge and use of honey as a food extends far back into antiquity, certainly centuries earlier than a reference dated some two thousand years or more before the Exodus of the Israelites from Egypt, and the use of honey as a sweetening agent antedates cane sugar by many thousands of years.

The first recorded use of beeswax was in the manufacture of wax candles, particularly candles for use in religous ceremonies for which it is still widely used. It is also used in medicine, and its commercial uses include furniture and floor polishes, cosmetics, transparent and wax paper, process engraving and lithographing, textile sizes and finishes and a host of others.

Honey bees collect nectar from flowers and manufacture honey upon which they feed; as a result of feeding on honey beeswax is produced. One pound of beeswax is the product of some seven to fifteen pounds of consumed honey.

BEE KEEPING AS IN INDUSTRY

As bee-keeping is an important industry in many countries, it is of interest to give some idea of the value of this industry.

To deal first with exports from producing countries; world trade in honey for 1959 amounted to over 53,574 tons, valued at $15,208,000 (£F6,083,200); these are exports only and do not include domestic consumption. In the United States of America the value of honey and beeswax produced amounts to over $28 million (£F11,200,000) annually, representing some 242 million lb. of honey and 4½ million lb. of beeswax Production in the U.S.S.R. is roughly the same as that of the U.S.A. Australia produces over 40 million lb. of honey of which about one-third is exported to the value of close under £1,000,000; beeswax production is over the 500,000 lb. mark. In Tanganiyka the value of honey and beeswax produced annually is some £1,000,000 and it is recorded that the value of these products obtained from areas of deciduous forest is greater than the value of the timber produced from the forests. New Zealand has a flourishing bee-keeping industry with exports of honey valued at £80,000 in 1959.

Production of honey in Fiji is at present almost negligible, although one or two persons have progressed with bee-keeping beyond the hobby stage. In 1959 Fiji imported 12,804 lb. of honey valued at £1,496; this works out at a value of 2s. 4d. per lb. or £13 1s. 7½d. per cwt. And yet, in 1958, the Island of Jamaica in the West Indies, in many ways comparable with Fiji and roughly the size of Viti Levu in area, exported 435 tons of honey worth $140,000 (£F56,000).

But, impressive as they are, the mere statistics of honey and beeswax production and exports do not by any means give the full picture.

Bees flourish in both temperate and tropical climates and there can be few agricultural industries that are as widely distributed throughout the world as bee-keeping. The majority of the world's agricultural crops are dependent on insects for fertilising their flowers and the bee stands supreme as a pollinating agent. Bees are entirely dependent on flowers as a source of the nectar and pollen, from which they feed both themselves and their young, and, in visiting flowers to obtain their food, they carry pollen from one flower to another and so help to fertilise the flowers they visit. The realisation of this fact, together with convincing proof from many countries that bee-keeping can result in better crops, is in itself ample justification for the importance which is attached to the industry. Fruit growers in many parts of the world realise the importance of the bee as a pollinating agent and will pay bee-keepers to place their hives in the fruit orchards during the flowering season. At the Agricultural Station at Nacocolevu two bee hives are providing bees to help cross pollinate passion fruit.

Here in Fiji there are many tons of nectar going to waste every year which could be turned into honey and there are several crops that would benefit materially from the pollinating value of bees. There are, of course, wild bees and other insects that do their fair share of pollinating; but they occur haphazardly and probably in insufficient numbers to be fully effective.

Cultivated plants which are of value to bees, and which in turn, can benefit from their pollinating activities, include the coconut, a valuable plantation crop in Fiji and which flowers throughout the year. Citrus is a good source of nectar; the avocado pear, mango, tamarind, guava, banana, cashew and coffee are also well up in the list, not to mention crops such as melons, cucumbers, pumpkins, various peas and beans and so on. Many species of ornamental plants also yield nectar and are visited by bees. In addition, there are large areas of unused land in Fiji which can be a valuable source of nectar from the several species of wild flowering plants which they carry. Certainly, in Fiji, the importance of bee-keeping to the coconut planter is far from recognised, nor is the value of such a hobby or sideline to the individual sufficiently appreciated.

Starting up the bee-keeping is an individual effort which does not require any large expenditure or capital outlay; in fact, it is best to start in a small way, learn by doing and then begin to develop; nor is it a time consuming job, the essentials being a knowledge of what to do and the correct time to do it. The beginner in bee-keeping must be enthusiastic and observant and prepared to make a study of his subject for, to make bee-keeping both profitable and pleasant, one must possess the requisite knowledge of the bee and its habits. The bee-keeper requires no expensive land; he can either site his bees on waste ground that has little or no other value or use the bees to help increase his cash crops by more efficient pollination by placing hives throughout his plantation.

LIVESTOCK OBTAINABLE FROM AGRICULTURAL DEPARTMENT

BEEF CATTLE—

	Each £	s.	d.
Pure bred Santa Gertrudis bulls	75	0	0
¾ bred Santa Gertrudis bulls	20	0	0
⅞ Zebu bulls	30	0	0
Zebu bulls	20	0	0

DAIRY CATTLE—

Friesian and Jersey bull calves and heifers

Dairy calves

From birth to 2 weeks old	2	0	0
From 2 weeks to 3 months old	4	0	0
From 3 months to 4 months old	6	0	0
From 4 months to 5 months old	8	0	0
From 5 months to 6 months old	10	0	0

For every month over 6 months add 10s. per month.
Culled cows 50s. per 100 lb. live weight.
Cream 4s. per pint + 3d. for carton.
Milk 5d. per pint.
Ghee 7s. per bottle.

BREEDING PIGS—

Weaning to 9 weeks	4	0	0
9 weeks to 10 weeks	5	0	0
10 weeks to 12 weeks	6	0	0
12 weeks to 16 weeks	7	10	0
16 weeks to 20 weeks	8	10	0
20 weeks to 24 weeks	9	10	0
24 weeks to 28 weeks	12	10	0
28 weeks to 32 weeks	14	0	0
Over 32 weeks of age	16	0	0
Gilts in pig	20	0	0

Fat pigs: 1s. 10d. per lb. live weight over 80 lb.
Fat pigs 2s. per lb. dead weight or current butcher price.
Pig crates 30s. local
Pig crates 50s. export

POULTRY—

Add 6d. each for export:
Setting eggs 10s. per set
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RIR & X/B. cockerel day-old 1s. each
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FARM PRODUCE—

Kumalas	2d.	per lb.
Tapioca	1d.	per lb.
Dalo	2d.	per lb.
Yams	3d.	per lb.
Bananas	2d.	per lb.
Cowpeas	1s. 2d.	per lb.
Maize seeds	6d.	per lb.
Potatoes	4d. to 5d.	per lb.
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Rice paddy (milling)	£1	per bushel
Urid	1s.	per lb.
Mungh	1s.	per lb.
Mauritius beans	7d.	per lb.
Eating nuts	1d.	each

SEEDS AND PLANTING SUCKERS AVAILABLE—

Rice seed dried to 12% moisture per ton	£60	
Coconut Varas	1s.	each
Banana suckers	1s.	each
Centrosema seeds	5s.	per lb.
Coconut seedlings—		
Large orders (Minimum order 500)	£30	per 1,000 plus freightage
Small orders	1s.	each
Seed nuts	6d.	each
Economic plants in pots	1s. 6d.	each
Grasses—		
Seed	5s.	per lb.
Roots	5s.	per sack
Kumala cuttings	5s.	per sack
Legume seeds—		
Large seeds	2s.	per lb.
Small seeds	5s.	per lb.
Cuttings	5s.	per sack
Budded Citrus	5s.	each

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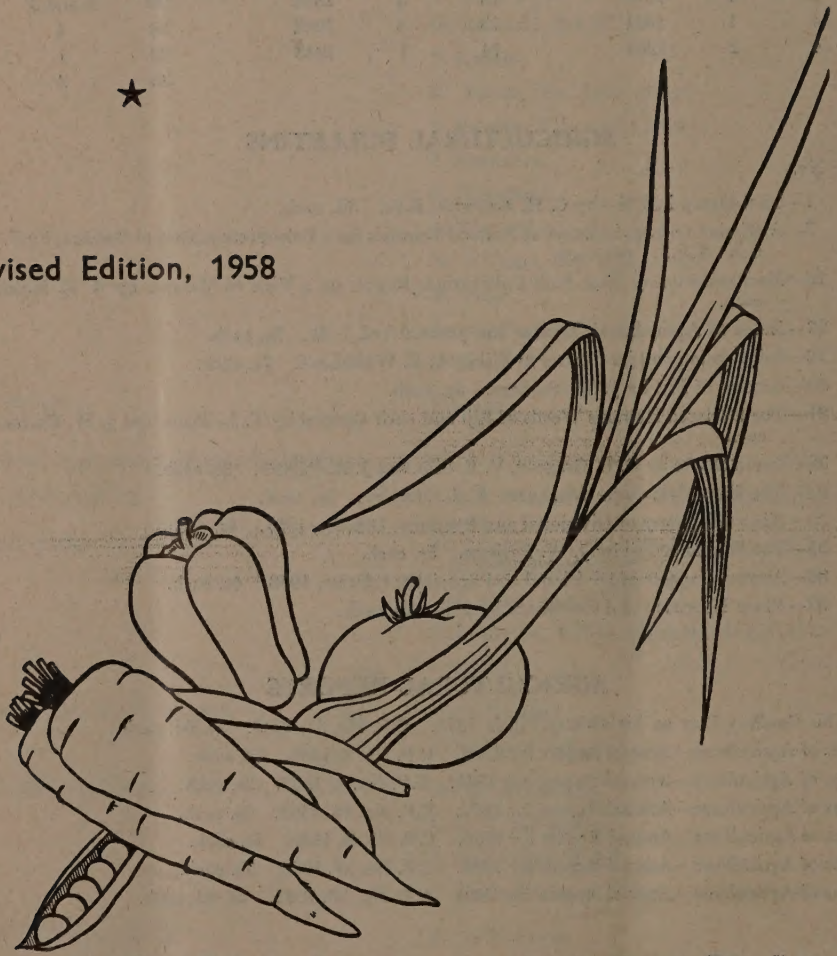

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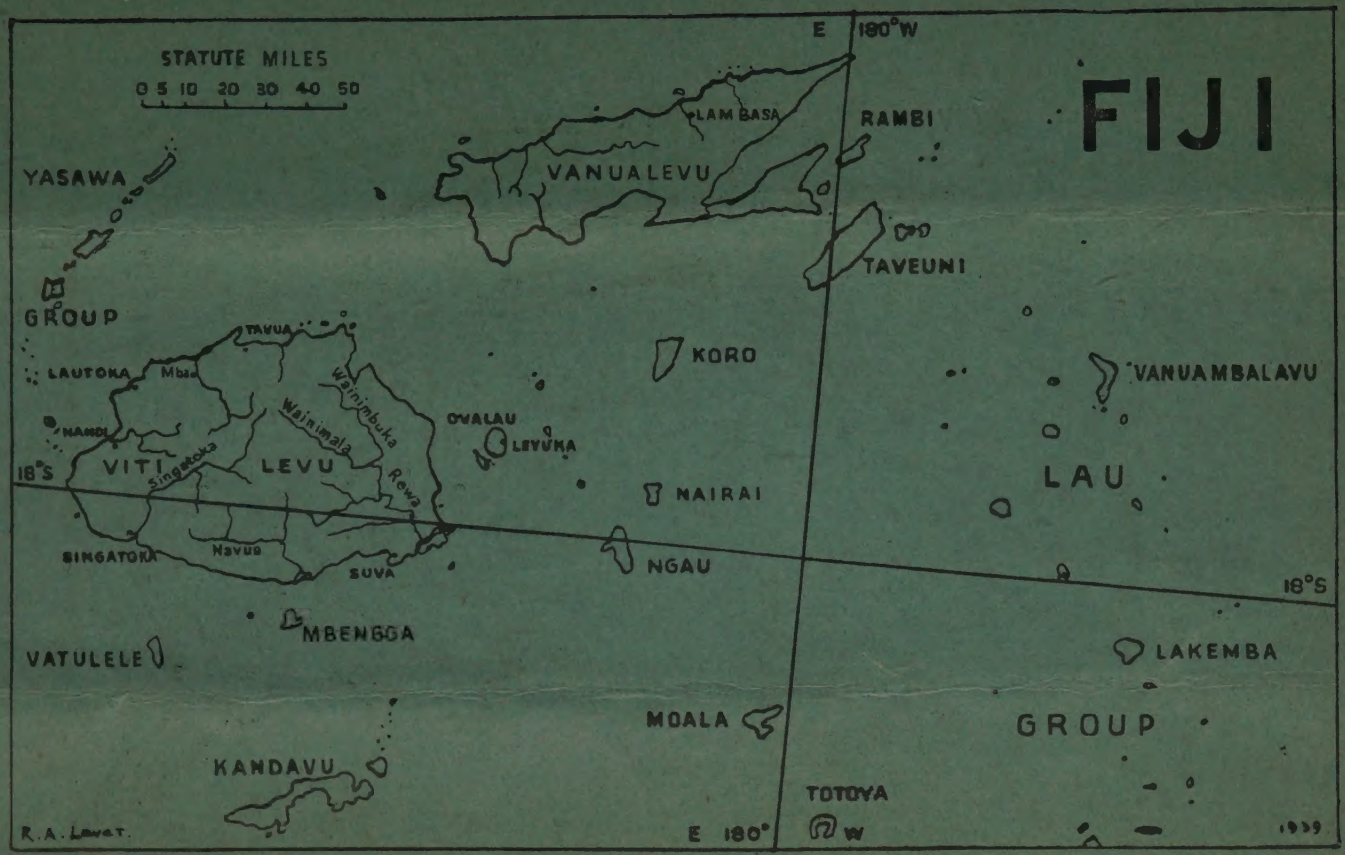

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